JAN 18 1960

TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

JANUARY 1960

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Baltimore Renaissance
Tolls on Indiana Turnpike
Washington's Mass Transit Plan
English Planner Views U.S. Traffic
Can We Solve Urban Transport Problems?
The General Traffic Plan in Germany
Connecticut Turnpike Influence
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Bridge and Tunnel Tolls
Taxicabs in London

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Eno publications are provided by income from an endowment by the late William P. Eno.

Volume XIV, Number 1 January, 1960

PRINTED BY COLUMBIA UNIVERSITY PRESS, NEW YORK, N.Y.

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8841

Traffic Quarterly

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Permission to reprint articles from this magazine may be obtained without charge on request to the publishers, Eno Foundation, Saugatuck, Connecticut.

Accidents

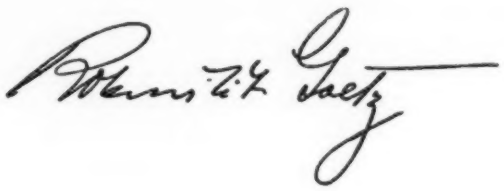
The annual motor vehicle death rate for the last six years has averaged 38,000. Of these, 400 occur each long weekend. The situation is common knowledge. Comments show that many observers are shocked, and a mystery to thinking citizens is why responsible officials are so slow to apply adequately corrective measures. Deliberately hazardous driving on the highways manifests unqualified drivers. No aspect of our varied system of driver-control on our highways could be less efficient or more disastrous.

Annually we improve our roads with better engineering, constant repairs, greater precautions in design against driving hazards and greatly improved methods of police control. It remains a monumental task to keep incapable and willful drivers off the road. The problem has many grave aspects, but with our present well-tried methods, we have made slight progress toward solution. Many concerted efforts toward motor-vehicle safety deserve the greatest appreciation. They are earnest, yet lack sufficient effectiveness to overcome national complacency. The only adequately forceful authority rests with the fifty states, and they are lethargic in their efforts to muster enough strength. As a consequence there is too little effort, too little impetus to improve our national driving characteristics. This is the shame of our lagging efforts, of our long forbearance and indefensible attitude. Weekend reports of high death-and-accident rates are commonplace, almost trite. Certainly this attitude does not spur those in authority to initiate definite corrective measures. Appropriate authoritative action may require time and patience but with a rewarding accomplishment of meeting the urgency of improved national driving habits.

Probably insurance companies were the first to classify drivers, setting special rates on young operators. These measures arose from necessity and good business practice. They are primarily protective, not constructive. Progress has been made in the field of parking. It came only after conditions that threatened business interests and city welfare, and dimmed the hope of properous city growth.

While we have made great improvement in roads and have ap-

proached perfection in vehicles, we have made little progress in our manner of using them if our death-and-accident rate is a measure of driving quality. There have been sporadic attempts but no concerted national effort by those in authority to correct a deplorable national problem.



The Long-Range Mass Transit Plan For the National Capital Region

ROBERT A. KEITH

Mr. Keith has been Project Director of the Mass Transportation Survey for the National Capital Region since 1958. Previously he served as co-ordinator of consultants on various phases of the survey. From 1952 through 1956, he served with a traffic consulting firm in New York City. Earlier, for two years, Mr. Keith was with the Massachusetts State Highway Department. He is a member of the American Society of Civil Engineers; an Associate Member of the Institute of Traffic Engineers, and a Registered Professional Engineer in the states of New York, New Jersey, Connecticut, and Florida.

THE transportation plan for the national capital region, including a design for future land use development, an estimate of future traffic movements, and long-range programs of highways and mass transit for the region, is intended to be adequate for the Washington area even when its projected 1980 population reaches three million.

Briefly, the plan contains the following features:

1. A network of freeways and express parkways throughout the region.

2. A new kind of fast, comfortable transit service from the suburbs through the central city into downtown Washginton. The transit service will take two forms:

a. Modern express buses on eight routes.

b. Modern rail transit service on four routes to be located in subways in the inner areas of the District of Columbia, and elsewhere in the median strips of freeways or on their own rights-of-way.

3. Arterial streets and highways extensively improved to carry automotive traffic not served by the freeways.

4. Expanded and improved local transit service on arterial and local streets, to carry passengers not served by the new bus and rail routes, as well as to service the express stations.

The cost of building and equipping the recommended new transportation facilities is estimated at nearly $2.5 billion, or some-

what more than $100 million a year. Express bus and rail transit facilities will account for about twenty percent ($564 million) of this total, as shown by Table I.

TABLE I—ESTIMATED COST OF THE RECOMMENDED TRANSPORTATION SYSTEM

Total		$2,486,100,000
Highways		1,803,000,000
Freeways	$1,401,400,000	
Parkways	220,150,000	
Major Streets	181,450,000	
Express transit facilities		564,100,000
Express bus	68,000,000	
Rail	458,500,000	
Parking at express transit stations	37,600,000	
Downtown parking facilities		119,000,000

TABLE II—EXPRESS TRANSIT SYSTEM COST

[*See also page 16.*]

	Millions
Route Construction	$433
Rail $402	
Bus 31	
Rolling Stock	73
Rail $ 44	
Bus 29	
Yards, Shops, Garages	21
Station Parking Facilities	37
TOTAL	$564

THE SURVEY PROCEDURE

Purpose and Scope of the Survey: Traffic congestion, slow and uncomfortable buses, and other deficiencies in transportation facilities inhibit the process of quick and easy communication, which is the basis of urban existence. The attractiveness of life in the suburbs is lessened by the difficulty of getting quickly and comfortably to downtown Washington and other focal points in the region, and urban blight is accelerated by continually increasing local street traffic, parking restrictions, and street widenings.

The National Capital Planning Act of 1952 directed the National Capital Planning Commission and the National Capital Regional Planning Council to prepare plans, as part of their general development plans, for the movement of people and goods in the region. Figure 1 shows the national capital region as established in 1952

for regional planning purposes, and the expected limits of the 1980 urban area. Later in 1952 a report to the commission on mass transit needs indicated that much more detailed information was needed before an adequate regional plan could be developed.

Figure 1. Jurisdictions, national capital region

In 1955 funds were made available for such a study as the Congress directed the commission and council to "jointly conduct a survey of the present and future mass transportation needs of the National Capital Region . . . and to report their findings and recommendations to the President."

The two agencies appointed a joint steering committee to plan and supervise the work .The committee consisted of two members from each of the two planning bodies, and three other members

representing the public utilities commissions of the District of Columbia, Maryland, and Virginia.

To supervise the technical studies, the steering committee appointed a small central staff, headed by a project director. It was decided to have the bulk of the technical work performed by consultants rather than by a large local staff, primarily because it was felt that the project would not take more than two years to complete. Had it been known that it would require four years to complete, more thought would have been given to developing a staff, as has been done in several recent studies in other cities.

The committee also retained an advisory panel consisting of several nationally known experts in various aspects of transportation. When the need for a complete study of highways was seen, a highway co-ordinating committee of area highway officials was established. Co-ordination was also maintained with a joint transit study commission representing the District of Columbia, Maryland, and Virginia, which had begun a study of transit regulation in the Washington area before this survey commenced.

Four major areas of study were laid out by the steering committee, survey staff, and expert advisors. These were: land-use planning, traffic studies, systems and equipment planning, and financial and organizational studies.

Arriving at the Recommended Plan: The survey proposals were decided upon after a thorough study of the region's future needs for transportation, and a careful consideration of alternative ways to meet those needs. The most important predictions about the probable character of the region's future growth and pattern of travel are:

1. The population of the region will increase from today's two million to three million about 1980. If the population reaches three million before 1980, as is quite possible, more transportation capacity may be needed in 1980 than proposed in the report.

2. The trend toward a dispersed population pattern will continue. More than eighty percent of the new population will live outside the original ten-mile square (the District of Columbia, Arlington County, and part of Alexandria). Growth will extend farther in some directions than others, however, as it is guided by the terrain, the availability of water and sewer services, and zoning policies. An especially large concentration of suburban population will lie to the north and northwest of Washington.

Residents of the dispersed suburban areas will make longer trips, and more trips per person, than today's population. These factors combined with the nearly fifty percent increase in population are expected to cause the total daily number of person-miles of travel to increase 200 percent by 1980.

3. Employment will increase moderately in downtown Washington to approximately 350,000 jobs. Downtown will remain by far the largest employment center in the region, and work trips into this area will constitute one of the most important regional traffic flows to be accommodated; rush-hour travel terminating downtown will be about twenty percent heavier in 1980 than today. Downtown Washington has two to three times more employment than downtown areas of most other cities of similar size, due particularly to the Federal Government offices.

4. The majority of new jobs, however, will be situated outside the downtown area in widely dispersed locations both in the central city and in the newer suburbs. The large increase in trips to the dispersed places of employment will lead to a tremendous growth in peak-hour trips through, around, or just short of the downtown area.

The magnitude of this diffused home-to-work movement is shown by the fact that the 24-hour travel across the boundary of the original 10-mile square will increase by more than 200 percent by 1980, while the 24-hour travel volume to and from the downtown area will increase by little more than twenty-five percent. This type of dispersed traffic flow will place new demands on the transportation system, of a much different sort from the radial flow in and out of the downtown area that is so prominent today.

5. Automobile ownership in the Washington area has always been greater than in average American cities, and it will continue to increase. The people of the national capital region, with more than two-thirds living in the suburbs, will rely more and more on the private automobile for most travel. More than eighty percent of the total regional travel will be by automobiles, even with the proposed transit system in operation. Truck traffic will also continue to be increasingly important.

6. Approximately fifty percent of the peak-hour travelers to the downtown area will not be in a position to choose between using public transit and traveling by private automobile. The other fifty

percent will be able to choose, and will base their choice upon the relative speed, cost, convenience, and comfort of these two modes of travel. Data show that nearly twenty-five percent in any case will have to travel by automobile, either because they need their cars at work, or for other reasons, and another twenty-five percent are certain to use transit, most of whom will not have motor vehicles available.

7. The peak volumes of travel in 1980, as today, will occur during the two morning and two evening rush hours on workdays, and will be mainly composed of trips between home and work. These are critical volumes that the transportation system must be designed to accommodate. With nearly one-half of the twenty-four-hour weekday travel occurring in these four peak hours, movement at other hours can be accommodated by facilities required to serve the peak home-to-work flows. Holiday and weekend traffic may well grow in importance in the future, but they will generally be more important only in the outer suburbs and public transit will not be affected.

8. Many important segments of the existing highway system are nearing capacity, and others are carrying more traffic than their rated capacities. Some travel desires are being suppressed by the lack of convenient facilities, and as new facilities are opened to use, much of their new capacity is absorbed by the release of the suppressed travel desires. The planned improvements in streets and highways will accommodate only a part of the anticipated traffic increase, and substantial additional capacity will be needed if the community wishes to prevent a lengthening in the time that both motorists and transit riders waste in traffic delays.

With knowledge of these general characteristics, and armed with a substantial number of other detailed facts and projections, it is time to consider the type of transportation to be needed. It was decided at the outset that a realistic study of the region's transportation problem would explore the ability of both public transit facilities and private automobiles to serve future needs. A comprehensive study of both modes in one survey is a rare thing for American cities.

To accomplish this, three hypothetical systems were initially considered, each consisting of a particular form of public transit

service plus whatever highways and streets would be needed to carry the people who would not travel by public transit under that plan, as well as the truck traffic. The three systems may be characterized as follows:

1. The "auto-dominant" system provided for continued local transit service of the present kind, sharing the streets and highways with other traffic and operating at low average speeds. This alternative would probably call for an extensive system of freeways, elaborate improvements to the other highways and streets, and large increases in downtown parking space.

2. The "express bus" system provided for express transit service by buses traveling on freeways, or on their own rights-of-way when this is necessary to maintain fast service. A freeway system would still be necessary, but it was expected that the amount of freeway construction, highway improvements, and downtown parking would be less than under the auto-dominant system. The present kind of transit service would complement the express service where passenger volumes justify it.

3. The "rail transit" system provided for express transit service by high-speed trains operating on their own rights-of-way. It was expected that this system, like the second, would require less highway capacity and less downtown parking space than the auto-dominant system. Despite its name, this system was conceived as using trains to carry large volumes of people. These trains, capable of a high degree of automotion, would either operate on conventional steel rails or on some form of roadway available through new technology. These trains would be complemented as needed by the present kind of local transit service.

The three hypothetical systems were evaluated by assigning the volumes of traffic projected for the three-million population to specific routes in each system (allocating trips on the basis of relative portal-to-portal travel times over different routes and by different modes), and determining the feasibility, cost, and desirability of the highways and express transit facilities needed to carry the traffic assigned to each route. Each system was tested several times as different arrangements of routes were tried.

The evaluation of the auto-dominant system showed it would be unfeasible, in the absence of improved public transit, to provide

freeway lanes sufficient to carry all automobiles moving along routes inside or near the ten-mile square. It would probably not be possible to accommodate all the cars on downtown streets and to provide all the parking facilities. Automobile destinations in downtown would increase by thirty-five percent in the morning rush hour and transit passengers would remain at today's level.

Under the second alternative, the introduction of express bus service on radial freeways was found to reduce the number of lanes needed on many freeways by attracting riders who would otherwise travel into or near downtown in the rush hours in private automobiles. It was determined that it would be generally more desirable to have the express buses use freeway lanes rather than to build expensive separate roadways. In the large downtown area, buses would use local streets as no distribution facilities were found suitable. More highways than so far planned would be needed, however, to accommodate the still great numbers of private automobiles, as well as to provide space for the trucks and the new express buses.

The inauguration of express bus service would not meet the region's transit needs, however, since these buses would be unable to carry all passengers attracted to a good express transit system. Passenger volumes from heavily populated areas to the north and northwest could not be carried through the built-up parts of the District by buses using the limited number of roadways that might be provided along these critical routes. Buses needed for downtown streets would, it was estimated, be too numerous to provide a manageable operation.

Evaluation of the third hypothetical system showed that rail transit could carry the large volumes of passengers along the routes where express buses were inadequate. Because construction of subways would be needed for most rail lines in Washington and would be expensive. Bus service could be provided at little additional construction cost on required freeways. Buses generally have an economic advantage on routes where they can physically accommodate the potential transit riders, despite the greater operating expense of buses.

For a large part of the Washington area, the potential transit riders would be of moderate volume due to the dispersed, low-

density, residential development so common to Washington. The high cost of rail route construction would not justify an express transit system solely of rail service by the time the population reaches three million.

Evaluation of the three hypothetical systems, resulting in the conclusion that no single one of them was entirely satisfactory, led to the design of a fourth system, embodying features of each of the others. This system was subjected to further tests and evaluation, which led to the conclusion that it should be recommended as best meeting future needs.

Today, approximately 55,000 rush-hour destinations to downtown are by transit. The proposed system would increase transit use in the rush hour to 90,000. Automobile travel would remain nearly level, at 100,000 person-trips.

The most important conclusions to be drawn from the evaluation of the three alternatives and the recommended system may be stated as follows:

An adequate transportation system for the national capital region must include a new form of express transit service, capable of attracting a large number of riders who would otherwise travel by private automobile from the suburbs to points in or near downtown Washington during the rush hours. Unless many of these riders were induced to use public transit, the highway system within the ten-mile square area could not accommodate those not in a position to travel by transit. Even after express transit has made its full contribution, the volumes of automotive traffic expected within a few years on many routes would be far greater than the capacities of the existing and previously planned highways. The region therefore faces the need for an expanded highway construction program as well as a new form of express transit service.

THE PROPOSED TRANSPORTATION PLAN

The proposed plan is a guide to a new transportation system for the national capital region. Its purpose is to fulfill a requirement that the planning commission and the planning council develop a mass transportation design as a part of their general development program for the City of Washington and the region.

As such, it provides this basic planning objective. In practice

it will hopefully serve, as should all planning proposals, as the framework within which legislative officials and operating agencies will make decisions that will lead to the building of a new transportation system. Unquestionably, details of route locations, and amounts of highway and transit capacity, will be revised somewhat before construction takes place. The proposed plan indicates for the first time the magnitude of the future traffic and of the cost of serving this traffic. The region will now have to decide how well it wishes to accommodate new travel desires. The plan also shows the need for additional governmental machinery to implement the proposals and create the system. The financial and administrative needs, which the commission and council believe to be the only important objectives at this time, are discussed in a later section. The following paragraphs highlight some details of the proposed plan.

HIGHWAYS

The recommended freeway system consists of 329 miles of freeways and parkways to serve the 400-square-mile urban area of the three-million-person region. Of the total plan (shown by Figure 3), eighty-one miles are already in existence, and another 178 miles are presently planned by the highway departments.

The remaining seventy miles are newly proposed in this report, although several of them have been referred to for many years without having received official recognition. Extra lanes and other improvements are needed on about half of the existing freeways, and additional lanes are proposed for some of the already planned routes. Miles of new, improved major streets are required. The highways would cost $1.8 billion.

EXPRESS BUSES

Express buses would operate over eight routes, totaling sixty-six miles of express operations (one way). Six routes would radiate outward from downtown and the other two would begin at the end of one rail line, as shown by Figure 2. All extend to points near the Washington Circumferential Highway, the interstate freeway that encircles the area at a distance of seven to ten miles from the White House. Many express buses would begin their inbound trips on

Figure 3. Proposed freeways

local streets in residential areas. They would enter the express system either at the outer terminal or at points along the route. Others would begin the trip at the route terminal. Ample parking space is proposed for the stations to attract riders.

Buses would travel on freeways or parkways in the same lanes as private vehicles. While stations would be located along the freeways at intervals of one to two miles, most buses would stop at only a few stations, or none, between the outer terminal and the edge of downtown. To insure free-flowing bus service, it would be necessary to give to buses various degrees of rush-hour priority in lane-use on most freeways. More favorable regulations on down-

town streets would be needed. If exclusive use of one lane was not allowed, there might well be need for two additional rail routes.

The bus system would carry approximately 340,000 fare-paying passengers each weekday in 1980, plus another 70,000 passengers who would pay their fare on the rail line but transfer to the bus system. The peak-hour, one-way volume at the heaviest load point

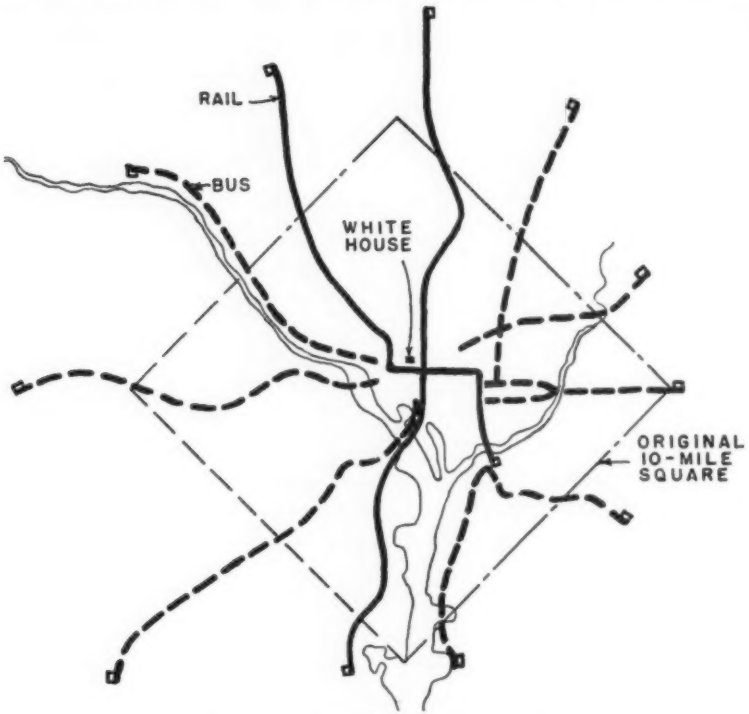


Figure 2. Proposed express transit

on each line is estimated at from 5,000 on one line up to 15,000 on two other lines. The cost of the bus system is estimated at $90 million, as shown by Table II. (See page 6.)

RAIL TRANSIT

There would be thirty-three miles of double-track rail line on four routes radiating from downtown Washington, with three of

the routes extending out to the Washington Circumferential Highway. Nearly half of the rail mileage would be in subways, including all of the mileage in the central area of the District of Columbia. The rest would be in the median strip of two freeways to the north and northwest into Montgomery County and on a separate right-of-way to the south into Alexandria and Fairfax County.

Stations would be placed at intervals of between one and two miles in the suburban areas, about a half-mile apart in the downtown area. There would need to be ample parking facilities at the stations, bringing the total number of parking spaces at express bus and rail stations to 32,000.

The rail system would carry approximately 385,000 fare-paying passengers each weekday in 1980, plus another 70,000 passengers who would transfer from the express bus system. The rail system's four routes would therefore carry a few more passengers than the express bus system's eight routes. The estimated peak-hour, one-way volume ranged from 12,000 to 27,000 passengers at the heaviest point on the lines. The cost of the rail system would be approximately $475 million, with more than $300 million for subway construction.

TRANSIT EQUIPMENT

Trains and buses proposed for the national capital region would represent a considerable improvement over the transit equipment in use here, or in most other American cities. They would need to be quiet, well-lighted, air-conditioned and attractively appointed —capable of rapid acceleration and deceleration, while giving the passengers a comfortable ride. Top speeds for buses would approach sixty miles an hour, and for trains, seventy miles an hour.

Rail equipment should embody some of the latest design features in use in European cities such as Stockholm, Hamburg and Paris, quite different from the older type of subway equipment in this country. Buses would be the largest practicable on downtown streets and would embody substantial improvements over even the newest equipment in use in this region. Equipment of this caliber would be essential if large numbers of commuters were to be attracted to public transit.

Consideration was given to new technological developments such as monorail, moving belts, automated buses and helicopters,

and to greater use of existing railroad service or rights-of-way. None was regarded as satisfactory as the corresponding parts of the proposed system. A monorail system, for instance, requires substantial structures that would not be acceptable in the public streets of most parts of the metropolitan area, whether along the curb line or in the center of the street. All portions of a monorail system, either supported or suspended, would be expensive and would include acres of storage. To date, the best that can be said for monorail is that it might apply to urban transit problems when it can be made to work under typical urban transit conditions. New technological devices will continue to appear, however, and full use would be made of them wherever desirable.

FLEXIBILITY AND FUTURE NEEDS

When the region grows beyond the three-million-population target of the study, and as unforeseen developments alter the traffic demand, it will be advantageous to add more travel capacity in some areas. By the time the need is actually felt, rights-of-way for additional freeways and transit lines would be far more difficult to find than at present. It is unlikely that any additional freeway routes beyond those proposed by the Transportation Plan could ever be established in the District of Columbia. To provide for this reserve capacity, it is recommended that the new radial freeways be designed with a sixty-four-foot center mall rather than the interstate-system minimum urban standard of thirteen feet.

The extra-wide median area provides for either additional automobile demands or additional express bus or rail transit demands. A one-way, three-lane, vehicular roadway could be added in the median. By reversing the direction of the extra lanes in the morning and evening rush hours, the effective capacity of the highway could be approximately doubled. If conditions were such that more transit capacity would be more advantageous than more automobile capacity, the extra center area could be devoted to buses or trains or some futuristic transit device. The sixty-four-foot width would provide for two transit lanes or tracks plus space for stations. Both the bus and rail medians are expected to be used in the Chicago area. The train method has already been put into use on the Congress Street Expressway, and will be built into the North

West Expressway. A wide median is also to be developed in yet another freeway to the south for the use of express buses.

Financing of extra width, including cost of land and extra construction of overpasses and other items, generally must be met by local jurisdictions without federal aid. In some cases, the extra land-cost presents no great problem. In most cases, the extra land- and construction-cost may amount to five or ten percent of the highway project cost. The relatively low cost of this insurance against unforeseeable future needs should encourage the Washington community and other metropolitan areas into action.

DOWNTOWN PARKING

Downtown all-day parking space would be required in almost the same amount as today. However, the expected loss of a large number of today's downtown parking spaces, on temporary lots and on the streets, would call for 22,000 new *all*-day spaces, most of them in multi-level structures; also for 27,000 new *short*-time spaces to replace some existing spaces to be lost, but chiefly to meet an expected increase in midday needs. Table III summarizes parking space needs. New spaces would cost approximately $119 million.

TABLE III—PARKING SPACE NEEDS IN THE CENTRAL SECTOR, 1980

	Short-time	*Long-time*	*Total*
Spaces required 1980	45,700	69,800	115,500
Spaces available 1955	21,000	75,000	96,000
Spaces to remain in 1980	19,100	47,000	67,000
Spaces to be provided by 1980	26,600	21,900	48,500

STEPS IN DEVELOPING A SYSTEM

Creation of a modern transportation system for Washington should take place in three steps:

First, immediate action would improve present local transit service in several ways while planning for the express system continues: by co-ordinating the routes and services of the several separate private operations on a regional basis, overcoming the barriers that exist at the jurisdictional boundaries and improving transfer conditions; by using better traffic controls and regulations

to help improve transit schedules; and by provision of adequate transit stations at key points. Though these things may appear simple to execute, they definitely require an improved form of government administration.

Second, the beginning of high-speed transit service should begin in the form of express buses in the early 1960's as some of the radial freeways are brought close to downtown. Advance planning and co-ordination between a single transit body and the numerous highway departments should begin early. Funds would be needed to build bus stations and access points into the original freeway construction. Funds would also be needed to acquire the extra-wide center median.

Third, rapid rail-transit service should be inaugurated no later than 1970 if traffic demands are to be met adequately. As eight to ten years of advanced planning and construction would be required to complete a subway system, this project should also begin in the near future. A regional agency with an ample budget and authority would be needed to initiate such a program.

While these three transit stages were taking place, there would be an underlying need for a bigger and more costly highway system to be built at a greatly accelerated pace. Accomplishment would require a greater degree of co-ordination between adjacent jurisdictions as well as determination to carry out the transit plans.

FINANCES AND ORGANIZATION

Paying for the System: The estimated cost of the recommended system is approximately $2.5 billion. As shown earlier by Table I, this figure includes about $1.8 billion for highways, $564 million for express transit facilities, and $119 million for parking facilities in the downtown area. Although it might be physically impossible to do so if funds were available, approximately three-fourths of the total amount would need to be spent within the next ten years to meet the growing traffic demand.

A part of the recommended freeways would be financed by the Federal Government, Maryland, Virginia, and the District of Columbia under their continuing highway construction programs. About $500 million of the highway costs would not be covered by present arrangements for highway financing. Additional funding

requirements would be without federal aid, if existing federal programs were not supplemented. This amount would need to come from new sources because the highway agencies already face serious financial difficulties in meeting present construction schedules. The magnitude of the problem of raising $500 million of local money can be appreciated when it is noted that local shares of present programs amount to only $400 million.

Under assumptions made as to transit fares, parking fees at transit stations, and the terms of financing the express transit system, revenues would be sufficient to cover operating costs and repay approximately half of the $564 million cost of the system. If metropolitan area bond issues were possible for borrowing money for the transit system and the $500 million needed of highway money, the annual repayment of principal and interest would amount to $16 million for the transit system deficit and $27 million for additional highway money.

There are two main potential sources of additional funds for this repayment: taxes and charges imposed within the region, and federal contributions in lieu of local taxes and because of the special federal interest in Washington. The most obvious sources of locally raised additional money are shown by Table IV. Not all these

TABLE IV—POTENTIAL SOURCES OF NEW REVENUE WITH THREE MILLION PEOPLE

	Millions
Motor vehicle tax of $10.00	$10
Motor fuel tax 2 cents per gallon	16
25 cents tax all day parking downtown	5
5 cents tax per $100 full-value real estate	10
1/10 of 1 percent tax on payrolls	11

sources, at least not in the amounts shown, would be required, and the best way of raising funds within the region would probably consist of a combination of several of them.

It would be up to the people, through their own governing bodies, to decide which means they preferred, for the transportation system the national capital region needs.

One of the greatest difficulties in raising funds would be that the bulk of construction cost would be incurred within the District of Columbia, while benefits to be gained and the resources to pay

for construction would be widely distributed. The federal government, as its contribution toward a sound federal city and region, should in particular make initial contributions toward the planning and design of the recommended rail system. It should also be prepared to provide funds for the early stages of transit construction, if a means for providing local funds on a metropolitan basis was not established in time. In view of the inability of state and local agencies to fully finance the highways required under the recommended plan, the federal government should study and take action on additional highway financing that would provide the necessary funds.

GOVERNMENTAL MACHINERY TO BE NEEDED

While the federal, state and local governments can independently carry out some of the steps leading to the creation of the recommended system, new forms of governmental organization are needed to complete the plan. Existing governments do not have all of the powers and financial resources needed. The development of the necessary organization would require the establishment of three new regional agencies, two of them to be established at once as temporary measures and later to be replaced by a third, ultimate form of organization.

Interstate Regulatory Agency: The first step should be prompt ratification by the Congress of an interstate compact primarily for the purpose of regulating transit throughout the metropolitan area. This agency would facilitate the integration of transit service across the jurisdictional boundary lines, and, with the aid of an advisory highway and traffic board, encourage the co-ordination of transit service with highway planning and traffic regulation. The compact would create a single agency to replace four public utility commissions that now act separately. Work has been under way by local jurisdictions for several years to get the compact approved, and final approval may come in the spring of 1960.

Federal Corporation: More than a regulatory body would be required to provide the region with the transportation system it needs. Prompt action would be necessary to make continuing transportation studies, to advance the transit system planning and proceed with engineering drawings, acquire rights-of-way, and

generally accelerate the highway program. To begin work in these directions, the Congress should at once establish a temporary public corporation. In addition to the above functions, the corporation should be empowered to construct and operate the proposed system in case the ultimate agency is not promptly created.

Interstate Proprietary Agency: Both the interstate regulatory agency and the federal corporation should terminate upon the establishment, by interstate compact, of an agency having more powers than both of them. This, the ultimate form of organization, would require time to create, since the negotiation and adoption of an interstate compact on this complex subject would be lengthy. This interstate proprietary agency should be empowered:

a. To construct and own transit facilities.

b. To operate transit facilities or make arrangements with private firms for their operation.

c. To finance its operation by revenues from transit fares, by the use of limited tax powers and by other appropriate devices.

d. To review highway construction plans as they may affect transit facilities and to consult with highway agencies on these plans.

e. To assist highway agencies in overcoming any deficit in funds.

f. To regulate and co-ordinate private firms engaged in public transit service.

This organization would have full powers needed by a regional agency to complement the work of existing governmental agencies in creating the proposed transportation system. It would be somewhat broader than a typical transit agency, in that it could raise funds for highways and see that highways and transit facilities were more closely co-ordinated. It would not lessen the duties and powers of existing highway agencies; it would enable them to meet their needs better.

PROSPECTS FOR IMPLEMENTATION

The report is now being explained to the public. The President has reviewed it, and a special joint committee of the Congress has held a week of hearings. The report has made it obvious to most people that regardless of differences of opinion on the particulars of the plan itself, some plan is needed and the only way to move toward better transportation is to create the right type of govern-

mental machinery. Until this is done, little can be done to advance the ideas in the report.

How far the community and its officials will go is indeterminate at this time. Like most cities, the Washington area never before had such a complete look at its long-range transportation needs, and their cost. The $2.5 billion price tag has shocked many people because they are not accustomed to seeing estimates for twenty years in advance. They probably would have acted just as shocked if the price tag had been announced as $1.5 billion, yet this is in fact the amount that would have been spent for highways and parking if this transportation survey had not been made.

Many are finding it hard to believe that we need both an expensive transit system and an expanded and accelerated highway program. It has been too commonly thought of as an either-or situation: either good transit *or* good highways. There are still those who think it unwise to invest in the heavy capital cost of rail subways, preferring an all-rubber highway-and-bus solution and its flexibility to meet changing conditions despite the fact that the studies show this to be inadequate.

On the other hand, there are those who have directly opposing views. Build the high-performance rail subways, slow down the highway building and make the people use transit, they say. Again, they disregard the survey findings that a large number of people cannot use transit. Holders of both views argue for various drastic changes in human behavior and urban development as the means to justify their pre-conceived judgments of what the metropolitan area transportation should be.

These groups had the same ideas before the survey. We hope these groups are smaller than they were four years ago and that the great amount of discussion going on will continue to whittle away at the size, thereby enabling the community to move toward the broad goals the survey has indicated. When the new governmental machinery is created, action on a community-approved plan can come quickly.

Editor's note: The Executive Office of the President, Bureau of the Budget, has endorsed the idea of rapid transit, a federal corporation to initiate its development, and the need for some federal financing. The following is from the Bureau of the Budget's statement: "Until the corporation has

been established and detailed plans prepared, it will not be possible to make the kind of financial analysis which would enable anyone to be definitive with respect to the self-supporting possibilities of the proposed transit corporation. We recognize that initial federal financing of the proposed corporation will be necessary." It is expected that the Administration will submit specific legislation to carry out their recommendations some time in January or February 1960.

Toll Factors for Indiana Turnpike

FARWELL RHODES, JR.

Mr. Rhodes has been public relations director for the Indiana Toll Road Commission since May, 1954. Previously he was on the editorial staffs of the Indianapolis (Ind.) Star, Franklin (Ind.) Evening Star and the Louisville (Ky.) Courier-Journal. He is a former chairman of the public relations committee for the American Bridge, Tunnel and Turnpike Association, and a member of the ABTTA'S special committee on truck promotion.

WHAT is apparently the most liberal discount system in effect on any toll road in the nation has become an effective business-builder for the Northern Indiana Toll Road. The Indiana toll road grants its customers, depending upon their monthly dollar-volume patronage, discounts ranging up to fifty percent.

This unusual discount arrangement together with a 1959 toll rate adjustment have been key factors in the Hoosier turnpike's steady year-to-year financial progress since its opening in 1956.

To appreciate fully the significance of the Indiana road's traffic and revenue potentials, however, you have to become acquainted with the road's history and development. The $280-million, 156-mile Indiana turnpike was conceived by Hoosier state legislators in 1951 as Indiana's answer to the problem of absorbing traffic off of the Ohio Turnpike which was already authorized and in the blueprint stage at that time.

The Indiana toll road connects on the East with the Ohio Turnpike and on the West with Chicago's seven-and-a-half-mile Calumet Skyway Toll Bridge. The Ohio pike is in turn joined with the Pennsylvania Turnpike which in turn connects directly with the New Jersey Turnpike. This interlacing of toll facilities affords the motorist 837 miles of virtually non-stop travel between 66th and State Streets in Chicago and the George Washington Bridge on the outskirts of New York City.

This turnpike network is the longest continuous stretch of superhighway in the world. Besides linking the two largest cities in the United States and connecting the Great Lakes area with the Atlantic

seaboard, this twin ribbon of turnpike serves directly, in the counties it traverses and the cities and towns it by-passes, a population estimated at twenty-two million.

REGION SERVED

The Indiana toll road cuts across the seven northernmost counties of Indiana and comes within a quarter of a mile of the Michigan border at one point. Thus, in addition to attracting New York-Chicago traffic, it provides a natural avenue between Detroit and Chicago and serves Western Michigan resort patrons to a considerable extent. Michigan cities such as Kalamazoo, Grand Rapids, Battle Creek, Jackson and Benton Harbor are within reasonable driving distance of the Indiana road, and the southern tip of Lake Michigan provides a natural barrier that shunts most of this Michigan-Chicago traffic through northern Indiana and the area served by the toll road.

The western end of the Indiana turnpike serves the bustling industrial complex of Lake County at Chicago's southern doorstep. This so-called Calumet area includes such industrial giants as the world's largest steel mill, the world's largest oil refinery and the world's biggest cement manufacturing plant. Cities in this area include Hammond, East Chicago, Whiting and Gary. Gary is one of the nation's largest steel centers and Indiana's second city in size.

The toll road in this area is also a favorite route for Hoosiers who commute to and from employment in Chicago. Thousands of these riders daily pass through the toll road's big eight-lane Westpoint Toll Plaza in Hammond, the so-called "Gateway to Chicago."

The Hoosier turnpike handles a large volume of livestock shipments to and from Chicago's Union Stockyards, also the world's largest of its kind. The Indiana road also is strategically situated to serve an unusually large segment of midwestern colleges and universities. Students find the road a convenient route between home and such schools as Purdue, Notre Dame, Valparaiso, Tri State, Michigan, Michigan State, Northwestern and Chicago universities.

Eastward from Lake County, the toll road serves South Bend, an auto manufacturing center (Studebaker-Packard); Elkhart, noted as the manufacturing center for more than sixty percent of

the world's musical instruments, and Angola, a resort center in lake-studded Steuben County.

The Indiana toll road, with its interconnections, has also enabled the major bus lines to compete timewise with the railroads on their Chicago-New York runs. One bus line maintains an eighteen-hour schedule between the two cities which is close to the fastest train time. This, then, is in general the main clientele and the area from which the Indiana turnpike draws its traffic and revenues.

BIG ROAD JOB

Construction of the Hoosier superhighway began September 21, 1954 and the entire road was in operation November 15, 1956. Completion of the road in 786 days' time was and still is regarded as the biggest roadbuilding job in the state's history. This meant that one mile of the toll road, together with all its buildings and appurtenances, was completed every five days! Services of 6,200 workmen, engineers and administrative personnel were required to get the job done.

The annual interest on the $280 million bond issue amounts to $9,800,000 a year or roughly $27,000 a day. Approximately $36,000 a day is required to cover both bond interest and operating expenses. In its first full year of operation, the road earned an interest coverage of .746 times. Passenger car revenue was near the preconstruction engineering estimate, but commercial revenue fell far short of the predicted $8,792,000 level by actually producing only $2,035,237.65.

Subsequently, the Indiana Toll Road Commission retained a traffic engineering firm for the operational phase of the road and, as general consultant, a firm that formerly served as a civil engineering consultant during construction.

The traffic engineering firm in collaboration with Indiana toll road administrative officials began late in 1957 an analysis of the road's traffic and revenue in an effort to improve it.

LIBERALIZED CUSTOMER DISCOUNT

Obviously, the first objective was to increase commercial usage. The commission's public relations department had already in-

augurated a truck promotional program, and commission representatives heard too frequently the complaint that the Indiana road's commercial tolls were above average for similarly situated turnpikes.

This was confirmed in a study by the traffic engineering firm, but a restrictive clause in the road's trust indenture prohibited the lowering of rates until certain reserve funds within the framework of the indenture were filled. This required several million dollars, and obviously a new facility with its earning power limited by excessive toll rates could not gain sufficient momentum to fill these reserves.

This problem was solved by liberalization of the commission's customer discount system which in effect resulted in a substantial rate reduction for truck and bus operators and even passenger car patrons whose use of the road exceeded $200 monthly in tolls.

Prior to March 1, 1958, the commission accorded all commercial patrons a ten percent discount on any volume of business done in excess of $2,000 monthly. Until that time, in fifteen months of operation, only $920.34 had been allowed in discounts under this plan.

But on the aforementioned date, the commission upon the recommendation of the traffic engineering firm inaugurated a new liberalized sliding scale discount as follows:

Monthly Dollar Volume	*Discount*
$200 or less	No discount
Over $200 but not over $400	10% of the amount over $200
Over $400 but not over $600	$20 plus 20% of the amount over $400
Over $600 but not over $800	$60 plus 30% of the amount over $600
Over $800 but not over $1,000	$120 plus 40% of the amount over $800
All over $1,000	$200 plus 50% on all in excess of $1,000

The objective of this action was to boost commercial revenues through increased patronage. The sizable discounts under the new schedule were and apparently still are the largest offered in the turnpike field and they had an eye-catching appeal for the economy-minded trucker. The result was immediate success. The number of truck company charge accounts handled by the commission jumped from eighty-one in February, 1958, the last month of operation

prior to inauguration of the new discount schedule, to 108 in August, 1958. The amount of discounts increased from $151.55 in February to $20,662.67 in August, but there was also a corresponding rise in commercial revenues from $187,858.45 to $264,540.30. During 1958, while toll revenues generally increased 17.7 percent over 1957, commercial tolls alone jumped 39.3 percent.

INCREASED USE DESPITE STRIKE

This trend toward rapidly increasing commercial use of the road carried over into 1959 and up to July 16 when the depressing effect of the nationwide steel strike began to temporarily curtail commercial traffic. In June, 1959, the last full month before the steel strike began, the number of charge accounts on the road had increased to 146; total discounts were $37,553.53 and the commercial revenue had climbed to $384,312.95.

Despite the temporary reduction in commercial traffic due to the steel strike, the road's August, 1959 statement showed an increase of 126,397 in commercial vehicle count and a boost of $942,233.40 in commercial revenues year-to-date as compared to year-to-date in August, 1958.

The hike in 1959 year-to-date commercial revenues of almost $1 million is also attributable in part to the other important action taken by the commission—the adjustment of tolls.

On January 20, 1959, the commission upon the recommendation of the traffic engineering analysts put into effect a new toll schedule which raised both passenger and commercial rates, particularly on the heavily used western end of the road which serves Lake County and the Chicago-Calumet area.

The new schedule was adopted after an intensive study of the road's 1958 performance showed an interest coverage of .85 times.

COST PER MILE

A weakness in the original Indiana toll road schedule appeared to be the charging of the relatively same basic per-mile toll for use of the more costly and advantageous Lake County section of the road as for the less advantageous eastern end between Elkhart and the Ohio line.

There was in this original toll schedule some deviation upward in the Lake County rate, but it was slight. While the passenger car

rate for a one-way trip across the entire road averaged 1.25 cents a mile, the rate for a trip between the Westpoint and Gary-East interchanges in Lake County averaged only 1.8 cents.

Some portions of the road in Lake County cost $10 million per mile to construct whereas cost of the road in the farming areas of central and eastern Indiana averaged approximately $1 million a mile. Much of the road in Lake County is elevated on steel structure, increasing snow removal costs. Snow normally plowed off the road must be hauled off the structures rather than pushed off below where it would endanger street-level traffic. Policing of the more heavily traveled Lake County section also costs more than policing of the remainder of the road.

HIGHER TOLL RATE FOR MORE TRAFFIC

The 1958 analysis showed that the 20-mile section of the toll road in Lake County was by far the most heavily used. The three Lake County interchanges (Westpoint, Gary-West and Gary-East) handled forty-seven percent of the entire road's traffic. This was a natural result of motorists' being able to avoid the heavy congestion of Gary, Hammond and East Chicago city streets by using the toll road. It also resulted from the naturally heavier traffic traversing Lake County between Chicago and Michigan.

For these reasons, it appeared that a substantially higher per-mile toll should be charged in Lake County than on the remainder of the road.

The traffic analysts established seven origin and destination stations in Lake County to check this theory. One of the stations was on the toll road and the other six were on parallel conventional routes.

Location of the stations were (1) on U.S. Route 30 east of Schererville; (2) on U.S. Route 6 east of Highland; (3) on the Tri-State Expressway east of Kennedy Avenue; (4) on U.S. Route 20 east of Cline Avenue; (5) on U.S. Route 12 near the Gary Airport; (6) on the toll road at the Westpoint Interchange in Hammond; and (7) on U.S. Route 42 near Wolf Lake.

The new toll schedule developed as a result of this study increased charges appreciably for both passenger cars and trucks making short trips over the Lake County section. But the rate of increase was gradually abated in proportion as the motorist ex-

tended his toll road trip, so that the increase for a full one-way trip was modest.

As an example, the toll for passenger cars between the Westpoint and Gary-West interchanges was increased from twenty-five cents to forty cents. But the passenger car increase for a one-way trip over the entire road was boosted only from $1.95 to $2.

Using the Class Four Commercial Vehicle (two-axle truck) as an example, the toll between Westpoint and Gary-East was increased from thirty cents to fifty cents, but between Westpoint and Elkhart it was only increased from $1.60 to $1.75.

The idea, of course, was to place a premium on travel over the most advantageous and most costly section of the road.

The analysts estimated that the higher rates would result in a 6.4 percent loss in passenger car traffic and 3.3 percent loss in commercial volume. But the net effect revenuewise would be an increase of slightly more than one million dollars annually in toll receipts. Considering additional factors such as vehicle usage, general traffic increases, and other growth trends, toll receipts in 1959 could be expected to increase approximately two million dollars above the 1958 level if the new rates were applied, it was estimated.

EARNINGS BEYOND INTEREST AND OPERATION

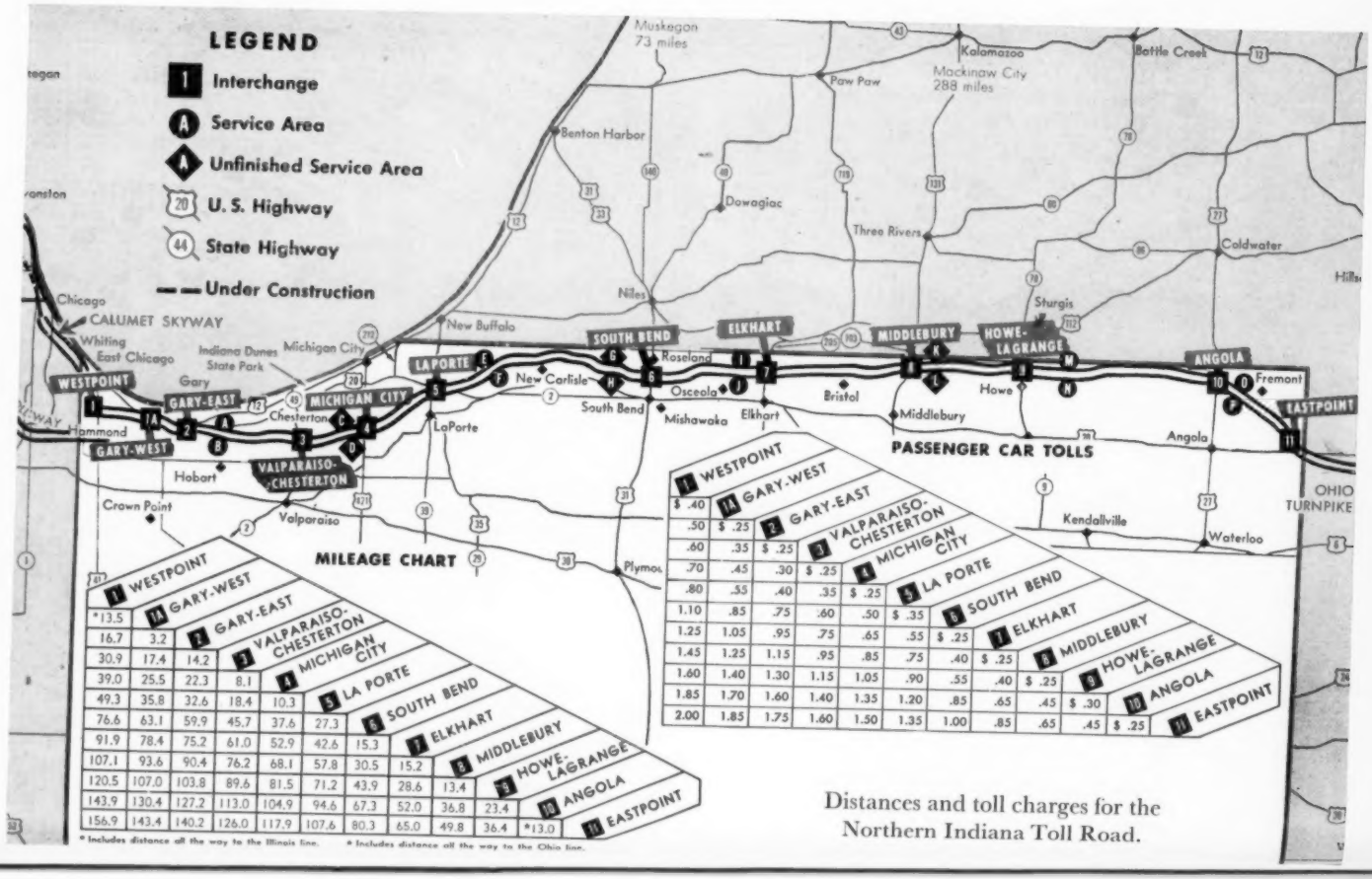
The traffic engineers, as a part of the same report, also recommended construction of new entry and exit ramps at the Westpoint Interchange to permit direct Hammond-Chicago traffic over the toll road and make greater use of the westernmost five miles in Lake County. Equipped with automatic toll collectors, the new ramps could be expected to gross $55,000 in 1959, the traffic engineering firm predicted.

With both the new toll schedule and the new ramps, the commission could expect its toll revenues to approximate $11,723,000 in 1959 and, with an anticipated increase in concession revenues, there would be sufficient receipts to cover minimum interest and operating expenses, the report stated.

Result of these studies and the adjustments in the Indiana toll road's discount rate and toll schedule together with completion of the new Westpoint ramps has been that the road at the end of September, 1959 was for the first time operating in the "black" on a year-to-date basis.

"Gateway to Chicago," the Westpoint Toll Plaza on the Northern Indiana Toll Road, one of the busiest toll road interchanges in the nation.

Complicated interchange on Northern Indiana Toll Road at Gary-East; construction cost was approximately $3 million. It affords connections with U.S. Routes 12 and 20 and downtown Gary.



1 WESTPOINT	14 GARY-WEST	2 GARY-EAST	3 VALPARAISO-CHESTERTON	4 MICHIGAN CITY	5 LA PORTE	6 SOUTH BEND	7 ELKHART	8 MIDDLEBURY	9 HOWE-LAGRANGE	10 ANGOLA	11 EASTPOINT
$ .40	$ .25										
.50	.35	$ .25									
.60	.45	.30	$ .25								
.70	.55	.40	.35	$ .25							
1.10	.85	.75	.60	.50	$ .35						
1.25	1.05	.95	.75	.65	.55	$ .25					
1.45	1.25	1.15	.95	.85	.75	.40	$ .25				
1.60	1.40	1.30	1.15	1.05	.90	.55	.40	$ .25			
1.85	1.70	1.60	1.40	1.35	1.20	.85	.65	.45	$ .30		
2.00	1.85	1.75	1.60	1.50	1.35	1.00	.85	.65	.45	$ .25	

1 WESTPOINT	14 GARY-WEST	2 GARY-EAST	3 VALPARAISO-CHESTERTON	4 MICHIGAN CITY	5 LA PORTE	6 SOUTH BEND	7 ELKHART	8 MIDDLEBURY	9 HOWE-LAGRANGE	10 ANGOLA	11 EASTPOINT
*13.5	16.7	3.2									
30.9	17.4	14.2									
39.0	25.5	22.3	8.1								
49.3	35.8	32.6	18.4	10.3							
76.6	63.1	59.9	45.7	37.6	27.3						
91.9	78.4	75.2	61.0	52.9	42.6	15.3					
107.1	93.6	90.4	76.2	68.1	57.8	30.5	15.2				
120.5	107.0	103.8	89.6	81.5	71.2	43.9	28.6	13.4			
143.9	130.4	127.2	113.0	104.9	94.6	67.3	52.0	36.8	23.4		
156.9	143.4	140.2	126.0	117.9	107.6	80.3	65.0	49.8	36.4	*13.0	

* Includes distance all the way to the Illinois line. * Includes distance all the way to the Ohio line.

Distances and toll charges for the Northern Indiana Toll Road.

Allowing for an average monthly interest requirement of $816,666.66, the road, on September 30, had earned almost $1,100,000 in excess of interest and operating expenses. Interest was covered an estimated 1.15 times during this period. The road had the biggest revenue month in its history in August, 1959 with a total net income of $1,571,157.03 and a coverage factor of 1.92. August 2 produced a new single-day toll revenue record of $63,561.10.

MILD PASSENGER CAR DECREASE

All of this was despite the fact that the new Westpoint ramps were not completed and put into operation until August 10 and that the road which serves the huge Gary steel industry was feeling the pinch of the steel strike.

Beginning with the month of February, 1959, the first full month of operation after the new tolls went into effect, and continuing through the month of June, the last month before the steel strike began, the vehicle count on the toll road was up 3.3 percent and toll revenues had increased 31.6 percent over the corresponding period in 1958.

Some mild defections in passenger car traffic were noted in the Lake County area where the toll increase was highest. The volume of passenger car traffic handled by the three Lake County interchanges (Westpoint, Gary-West and Gary-East), decreased 3.6 percent during the February–June period in comparison to the corresponding 1958 period. But commercial traffic by this same yardstick actually increased 10.2 percent.

Eastward along the toll road from Lake County, traffic was generally on the increase despite the higher tolls, but the rate of increase may have been curtailed slightly. An indication of this is the fact that while traffic over the entire road increased 3.3 percent during the February–June period, this contrasted with a 6.4 percent traffic increase in December, 1958 over December, 1957. December, 1958 was the last full month prior to application of the toll increase.

OTHER FACTORS IN EARNINGS STATUS

Meanwhile, gross revenues from the new Westpoint ramps averaged approximately $200 daily for the first twenty-five days of August. On a projected annual basis, this would exceed the traffic firm's estimate, but this reflects normally heavy summertime traffic

only. A longer operational period will be necessary to assess accurately the revenue potential of this new source of income.

The liberalized discount system and the toll adjustment have been the major factors in the Indiana road's improved earnings status, but other factors have contributed less prominently. These include:

1. While the road's income has increased, expenses have declined. September, 1959 year-to-date operating costs were an estimated $154,300 lower than September, 1958 year-to-date costs. The commission recently tightened its pursestrings further by approving an operating budget for 1960 which is $115,346 below its current budget.

2. Increased traffic plus construction of six new service areas by Standard Oil of Indiana has increased revenues from the sale of gasoline. Total concession revenues at September, 1959 year-to-date exceeded those for a comparable period of 1958 by an estimated $116,500.

3. Like most new superhighways, the toll road has breathed new life into the economy of the area it serves. This in return is providing more traffic for the road. The road's economic contribution to northern Indiana is two-fold. Directly, construction of the road fed $60,617,873.15 into the pockets of fourteen Indiana-based prime contractors and eighty-eight sub-contractors. In its operational phase, the road has created an estimated 1,350 new, permanent jobs; and payrolls attributed to the road's operation both directly and indirectly total $3,530,186.70 annually. During 1958, the toll road commission, its concessionaires and associates purchased something like $8,950,000 worth of products and materials from Indiana-domiciled companies.

The road indirectly has been a big drawing card for new and expanded industry. The Indiana State Department of Commerce and Public Relations found in a recent survey that of 112 Indiana cities and towns that have been blessed with new industry during the last three years, thirty-five were located within a forty-five-mile band straddling the toll road. And of 354 new industries, 156 of them or approximately forty-four percent of the total were situated in these thirty-five communities.

The biggest industrial plum thus far has been a new $100 mil-

lion steel mill being built a few miles north of the toll road in Porter County by the National Steel Company. The new mill will be in the Burns Ditch Harbor development which eventually is expected to become a shipping terminal for the St. Lawrence Seaway, opening another avenue of commercial traffic for the turnpike.

4. An alert, all-weather maintenance program that keeps the Indiana turnpike operable during the many fierce blizzards that blow into northern Indiana off Lake Michigan has made the road a popular haven for truckers during these emergencies. One of the biggest commercial revenue days the road ever had was during the midst of one of the state's worst storms—February 18, 1958. On this date, the road took in $15,961.95 in truck and bus tolls while most of northern Indiana was buried under a 55-inch snowfall.

5. A modest billboard advertising campaign during the past summer directed motorists to the toll road from points in Illinois and southern Michigan and an expanded $75,000 advertising program has already been approved for 1960. Much of it will be concentrated in the Chicago area where even a superhighway might escape notice.

6. Continuous personal solicitation of truck companies and other potential commercial customers is being conducted by the commission's solicitors who are bulwarked by both passenger car and truck trial-run results over the Chicago-New York turnpike system, reflecting savings in driving time, fuel consumption and mechanical depreciation as compared to public road travel.

Renaissance in Baltimore

DAVID A. WALLACE

David A. Wallace is Director of The Planning Council of the Greater Baltimore Committee. Prior to coming to Baltimore a year ago, he was Director of Planning for the Philadelphia Redevelopment Authority for the previous three and one-half years. He is licensed to practice architecture in California, Illinois, and Pennsylvania.

He has worked for architects and practices architecture in Philadelphia, Berkeley, Los Angeles, and Chicago, where he was also a supervising planner for the Chicago Housing Authority. He served a year as Associate Director of a Marshall-Field Foundation Research Project.

Mr. Wallace was assistant professor of City Planning at the University of Chicago for six months, and recently a Visiting Lecturer in City Planning at the University of Pennsylvania.

He is a member of the American Institute of Architects, American Institute of Planners (Board of Governors), and the National Association of Housing and Redevelopment Officials.

CITIES all over the country are slowly waking up to the challenge of the twentieth century. A late starter, Baltimore may have the added advantage of coming from behind. In a town that has been plagued by false starts, the old real estate adage that things have to get very bad before they can get better takes on real meaning.

And Baltimore seems to be awakening from a long day-dream that started with the Civil War. One notices a heightening awareness of a need for action, a new civic pride, a growing understanding that sights must be raised far above the mediocre standards that have characterized much of the city and its life. Maybe it's the Colts and the Orioles. At any rate, a fresh wind is in the air and the Renaissance is definitely on. This is the story of Baltimore's awakening—as it relates to its downtown.

In 1955, recognizing the need for action on this and other fronts, business leaders formed the Greater Baltimore Committee to accelerate work on a broad range of needed projects. In August, 1956, they established the Planning Council as a separate professional planning organization to aid themselves and to be available for

hire as a service to the community. Downtown was one of the Greater Baltimore Committee's major areas of concern.

The Department of Planning had conducted studies of downtown, and its director had published a schematic proposal. This proposal both outlined the general objectives of a downtown plan, and brought the attention of the community to the need for such a plan. However, the department's program and organization prevented the concentrated effort needed to produce a downtown master plan. Realizing the need for a more focused approach to downtown problems, a group of retailers, bankers, and property owners formed the Committee for Downtown, Inc., in 1955. Their objective was to raise funds for the development of a downtown master plan.

The committee for downtown turned to the newly formed planning council and retained its services with $150,000 raised from a voluntary, self-assessment of more than three hundred subscribers. The council employed a professional staff in the early part of 1957. It began work May 1st under a contract signed in the presence of Mayor Thomas D'Alesandro, and with the pledge of his administration's co-operation.

DOWNTOWN RENEWAL AND CHARLES CENTER

Convinced that downtown problems could not be dealt with solely by private enterprise, the mayor and city council designated the entire downtown an urban renewal area on January 24, 1958. Presented by the planning council on March 27, and approved by the voters on November 7, 1958, the Charles Center project was the first on the planning program.

On March 23, 1959, the city council unanimously approved condemnation ordinances for both Charles Center and the Civic Center (municipal auditorium and arena). By signing these ordinances into law on March 25, the mayor authorized the city to acquire the sites and proceed with the project.

The development of Charles Center in advance of completing a plan for the whole CBD was a calculated risk. It was obvious decisions might be made for such a project that, from a broader point of view, could be wrong. Yet it was evident, upon preliminary analysis of CBD problems, that there was no alternative to a major renewal project. Without it, possibilities for the immediate future

of the central business district looked very poor. Past trends, almost all downward, would probably continue. Planning for appropriate land uses, traffic, transit, and allied problems, would resolve into deciding what would be left after every "footloose" activity had departed.

Figure 1. Charles Center in downtown Baltimore.

THE MARKET FOR CHARLES CENTER

Knowledge of the potential market for space in Charles Center had been learned in two ways. First, a regional forecast gave a very favorable long-range picture of growth for the region as a whole. Second, an intensive business community survey identified specific firms that were at, or near, points of decision regarding a change in location and expansion.

This long- and short-range information was combined; it became apparent that there was a good market for a substantial

amount of new office space, a smaller amount of retail space, a new hotel and a new theater which would combine a number of existing facilities. There was also need for a transportation center to which express buses could provide service to a wider area than Charles Center itself.

Summaries were made of the amount of space needed by various firms interested in building their own buildings or in moving to new locations in existing buildings. The combination of new regional growth, plus expansion of existing Baltimore firms, is now being channeled through strong planning and management into actual demand for the space proposed in Charles Center.

PLANNING CHARLES CENTER

The mayor's promise of co-operation was not an idle one. Without the active participation of his departments, Charles Center could not have moved from an idea to reality in the short five months of its development.

Specifications for the site were strict. They included such elements as adequate size and dramatic appeal, feasibility without federal aid, creation of opportunity for new investment, diversification of market potential, creation of incentives for rehabilitating adjacent properties, elimination of blighted, uneconomic, unstable and socially undesirable land uses, and contribution to solving larger traffic, parking, and transit problems.

It was found that the Charles Center area was the only one that met all the specifications. It was also the only area within which a composite and integrated project of the kind proposed could be successfully carried out. The site is presently a zone of economic instability, yet it is an area of underdeveloped economic potential.

Development of the site will inject new vitality into the critical downtown area lying between Baltimore's healthy financial district and the major downtown retailing cluster, centered at Howard and Lexington Streets. Not only is the site sound in terms of present economic and building conditions, but it is also advantageously located in terms of existing and future plans for urban renewal and housing development.

Once the general site area was agreed on, detailed studies were undertken concerning the future street pattern, parking, acquisi-

tion, cost, and relocation. Baltimore's commissioner of transit and traffic is quoted as saying he is still pleasantly amazed that he was asked what streets might be closed. He immediately set out the possibilities for traffic realignment and suggested a transportation terminal. The Department of Public Works realigned utilities and estimated costs.

The Baltimore Urban Renewal and Housing Agency, which now has responsibility for the project, advised on all of its aspects during the planning phase.

Equally important, as Charles Center began to take definite shape on the drawing boards, key businessmen in the community, who were concerned, were consulted. In this way, the project was largely pre-sold to an important segment of the community involved in its development.

FIVE PLANNING PRINCIPLES APPLIED

Charles Center represents a practical application of certain fundamental planning principles. The first is that of open space. Three small squares are designed as focal points for intensive development around them. These are essentially public in character.

The second principle is the inclusion of intensive mixture of uses. Around the squares, retail space is evenly distributed, with major emphasis on tying the retail activity in the main shopping center at the west to the financial center at the east. Office towers are located to insure light and air, support the retail below, and distribute pedestrian and vehicular traffic. As a third principle, these are completely separated by a system of pedestrian walkways that make use of the site's sloping topography to bridge the various streets.

The fourth principle groups all of the land uses and functions in three major super-blocks, created by closing four streets. Parking is located in a 4,000-car underground garage, accessible from the peripheral streets and under the activities it serves, in accordance with the fifth principle.

ECONOMIC CONSEQUENCES OF CHARLES CENTER

The impact of Charles Center on other buildings of the city and on the city's tax structure has been carefully analyzed. The

experience of other cities, interpreted in the light of Baltimore development trends, suggests that the Charles Center development will produce a short-run increase in office-building vacancy. In the long run, however, it is reasonable to assume that the addition of office-building space in the Center will help to stimulate an overall growth of the office-building market.

Thus, as Charles Center helps Baltimore to increase its importance as a regional capital, the overall demand-level for office-building space throughout the city should increase. Similar conclusions can be drawn with regard to retail space and the hotel. In the long run, Baltimore's growing importance as a regional capital, based in part on the influence of Charles Center, will lead to new levels of operating activity and generate new business.

Concerning the economic consequences of Charles Center on the city's tax structure, analysis points up the fact that for a short time a large block of taxables will be removed from the tax base, but eventually the increase should be substantial. The present taxes from the area approximate $500,000 a year. Estimates of future taxes range between two and three million dollars a year, an increase that will amortize the Center's total net cost to the city in ten to fifteen years.

The new property yielding these taxes will be free from the threat of continuing deterioration and blight that now affect large sections of the site area, where property values have been in a gradual but persistent decline for a number of years. Many competing properties outside the site area will probably suffer a short-term reduction in operating levels because of the Charles Center development. These properties in the long run will benefit so that the net effects of Charles Center on the city's total tax structure will be favorable.

It is on the strength of these economic consequences that Charles Center stands as a local urban renewal project. Although the site was an area of economic instability, it does not qualify as a typical non-residential slum area. However, it was easily demonstrated that the whole of downtown has been deteriorating and will continue to deteriorate if new lifeblood is not injected into it. Charles Center was justified and approved as being necessary to halt the deterioration of downtown as a whole.

An immediate, positive result of Charles Center's impact was the location of the city's Civic Center west. Prior to the development of Charles Center, the city considered constructing a new civic center to house a 10,000-to-13,000-seat arena for both sporting and cultural events. The Civic Center Commission, created by the city, had not been authorized sufficient funds to acquire a site.

THE CIVIC CENTER

As a result, they had to look for either a very inexpensive or free site, and recommended a site in one of the city's parks, some distance from the downtown area. A taxpayer's suit subsequently invalidated this decision. In the meantime, Charles Center had been proposed, and so changed the Commission's thinking in regard to a downtown location that the civic center commission asked the planning council to consider possible locations within the central business district. The council recommended a site subsequently adopted by both the civic center commission and the city council, immediately adjacent to Charles Center.

The imminent development of the new civic center, next to Charles Center, substantially enhances the attractiveness of Charles Center for new investors. At the same time the civic center becomes an important factor in revitalizing the downtown area.

PROGRESS OF THE TWO CENTERS

First announced to the city on March 27, 1958, the Charles Center plan was approved by the voters in November of the same year with the authorization of a bond issue for $25 million as a working capital fund. In the same election the voters also approved an addition of $6 million to the initial $6 million allocated for the civic center. The city council subsequently approved the two ordinances for acquiring the sites for both centers. The civic center property, comprising a four-block area, has now been substantially acquired and cleared. Construction will begin in March.

The Charles Center development is proceeding at an equally rapid rate. Acquisition appraisals have been completed for a substantial portion of the entire area, negotiations for part of it are under way, and developers of the cleared land are currently making

detailed plans. The Baltimore Urban Renewal and Housing Agency, responsible for the project, has already received concrete proposals from a number of firms for half of the project.

PARKING AND TRAFFIC IN CHARLES CENTER

In translating the plan from concept to steel and concrete, certain details have been further developed. Initially, a 4,000-car underground parking garage was proposed, which would extend under the entire site and operate as a unit. After intensive study of problems of development ownership and operation posed by this single unit of parking space, consultants to the Urban Renewal Agency advised subdividing the major parking garage into two types of parking.

The first is parking space under individual buildings within the general excavation that the building would entail. This plan would provide for essentially tenant-parking on an all-day basis, to be rented with the office and retail space above, directly under control of the individual developer of each site.

The second type of parking is under the three public squares and in front of the hotel. Developers may make use of the financial facilities of the city's off-street parking commission through low-interest, long-term loans. Units can be operated by parking garage operators in accordance with general practice in the central business district.

A total of 1500 spaces has been allocated in the Charles Center plan for the first type of parking and up to 2500 spaces for the second type. The development of public parking in commercial garages would be completed when economically feasible.

This change in the parking layout had an impact on the traffic pattern. Under the revised scheme worked out by the Department of Transit and Traffic, entrance and discharge parking loads are considerably distributed to all of the adjacent streets. Since these streets will be substantially widened, they will be capable of taking the load.

Early civic center plans called for 3,000 car spaces. Since the civic center is to be located downtown, with most of the events at night and on weekends, a substantial amount of the central business district parking is available immediately. In addition, the civic

center commission plans to build 400 car spaces underneath and adjacent to the arena itself. When all of the parking has been developed in Charles Center, this facility may no longer be necessary and can be converted to additional exhibition space of which there is planned 100,000 square feet.

THE CBD PLANNING PROGRAM

The planning program that developed Charles Center, served to locate the civic center, and formed the basis for the CBD Plan, got under way on May 1, 1957. Terms of the council's contract with the Committee for Downtown specified a plan for the central business district, the area of major interest to the contributors of funds for this work. Boundaries of the central business district were designated arbitrarily to include as large a survey area as available funds permitted. The contract also included provision for study of such adjacent areas and larger problems as proved necessary and possible. Co-ordination with the work of various city and state agencies and departments was critically important in making possible such a relatively short planning program.

Planning for the future of the CBD involved breaking the CBD into its constituent parts, analyzing each separately and in relation to each other, and then suggesting new and better ways of rearranging the parts to produce a viable whole. The use of some form of projection or forecast was necessary in the process.

The method used in the plan combined elements of all known techniques of forecasting future CBD space requirements. However, the greatest dependence was placed on knowledge of local growth potentials viewed in light of a conceptual framework of what the CBD ought to be. These two factors were merged in the process of developing the plan. The final programming of long-range, functional employment and floor-space requirements for the plan was not based upon projections alone.

FUNCTIONAL MODEL OF FUTURE CBD

The underlying conceptual framework was the achievement of a balanced arrangement of future functions in the CBD. This functional model of the future was created from a combination of three general economic analyses.

1. Economic potential of the function: from regional and CBD

forecasts, determination was made of the potential for increased, stable, or declining level of activity, employment, and floor space in each function. This finding was then modified by further data from subsequent studies.

2. Locational analysis: the basic efficiency of a central location for carrying out each function was analyzed. A determination was made of the possibilities for feasible use of high-value central sites for each use. This study involved an intensive examination of the past and future dispersion- or concentration-tendency of each activity.

3. Linkages and compatibility: investigation of the positive or negative effects of a use on adjacent activities, and the extent to which activities are mutually supportive or linked.

Stated in theoretical terms, the quantity and quality of future functional CBD uses should result in a composite highest and best use of the entire CBD. The total of all CBD uses would, in large measure, result from natural market forces as they affect the individual sites composing the CBD, if the market operated efficiently. However, the use of a large-scale, publicly supported renewal undertaking was found necessary to accelerate the functional adjustments of the CBD: hence, Charles Center.

The use of every single site need not bear this marketplace test of maximum return. Even in strictly private enterprise, large-scale undertakings, such as shopping centers, include activities that usually have no direct money return (parking), and activities that themselves do not meet a pro rata share of their costs because they permit leasing of the remaining development to profitable undertakings. The goal of the CBD program is to create the highest aggregate economic value and return consistent with important social values. This goal should coincide with the development of the highest aggregate property values and thereby the highest total property-tax return to the city.

The plan developed is a composite of short- and long-range plans and certain detailed component projects. The plan does not purport to solve all central business district's problems, nor is it a finished picture of the exact development foreseen by 1980, or any other date. It contains no "illustrative site plan." It includes elements of flexibility based on the obvious inability to forecast with exactitude such things as future technological developments.

The plan proposes projects, where their development presently appears feasible, and suggests further proposals as part of a longer-range program offering possible future opportunities for additional renewal action. These potential projects require detailed re-examination when their timing becomes more imminent. The plan demurs from concrete proposals where further study is required or where projects have doubtful feasibility.

The process of planning—the continuous, thoughtful application of theory and data to solve the problems of creating a desirable and efficient physical environment—is more important than lines on paper, or even specific proposals. These inevitably have a static and inflexible quality. Continued planning and restudy are necessary and desirable after the publication and adoption of any plan.

LAND USE IN THE CENTERS

Charles Center and the civic center became the keystones in carrying out the first part of the functional model and in developing the land-use plan for the central business district. What these two uses do is further to consolidate and concentrate the intensive activities in the entire core of the CBD. This intensification is a fundamental principle behind the planning for Baltimore's downtown.

A twenty-year office-development program was devised as a fundamental element of the whole CBD plan. It includes the construction of 2.9 million gross square feet of office space in Charles Center, predicts private rehabilitation of 3.3 million gross square feet in existing buildings, and recommends 3.5 million gross square feet of other new office building construction in the CBD. The area designated for this intensive development is immediately adjacent to Charles Center, between it and the office and financial districts to the immediate east.

Other land uses are determined either by the character of the existing area or by the potential for various types of space. Several areas are left in their present light industrial and commercial use pending further analysis. These are, in effect, areas of indeterminate use and will undoubtedly become more clearly appropriate to some other use as the plan is put into effect.

An important conclusion was that, with certain major excep-

tions, the traditional CBD activities of manufacturing and light industry should decline. This was not a prediction of what will probably happen, but a recommendation for a positive policy of eliminating those uses in the CBD that do not qualify as highly intensive, either as to space or as developers of high land values. Charles Center and the civic center force the relocation of a substantial number of these uses. Only those industrial uses which clearly support intensive uses, such as job-printing, are proposed to remain.

DOWNTOWN SHOPPING TO BE REVITALIZED

Along with office space, retail trade is a vital, centralized CBD function. In the development of the plan, analysis traced recent trends in retailing in the CBD. Projection of these trends pointed to a gloomy picture. Baltimore has been undergoing an experience similar to that apparent in national retail trends. At the same time that CBD retailing has lost suburban shoppers, the "captive market" of CBD employees in Baltimore has not been tapped to the same extent as in other cities.

In spite of the gloomy picture it was evident that the CBD had tremendous strengths that suburban shopping centers could not entirely discount or duplicate. The CBD is the only shopping area well served by mass transit, reaching into all sectors of the region. This is an advantage in terms of both market and labor supply. To date, in the Baltimore area, no single regional center has been built that can approach the pulling power of the CBD concentration. The high cost of further suburban expansion considerably offsets possible new sales, where capital costs in the CBD have been largely amortized.

Even though the immediate prospects of retailing are poor, the long-range prospects seem considerably better. Over the next six years, major revitalization of the CBD will create new retail opportunities for the main shopping center. Charles Center will concentrate 20,000 employees and 5,000 visitors a day close by. The civic center will add as many as 13,000 visitors per event, particularly at night and on weekends.

Many of these will come from far out in the region. The University of Maryland campus development at the western edge of the

CBD and new downtown housing envisioned as part of the overall renewal program will also add measurably to the improved environment by clearing adjacent business and residential slums.

Within the next five or six years, the Jones Falls Expressway, now under construction, will almost halve the time from the important north and northwest sectors of the region. Within ten years, the east-west expressway will greatly reduce driving time from the northeast, east and western sectors. While it can be argued that this will accelerate the outward flight of residents, the reverse can be true if renewal strategy creates proper opportunities.

Skilled merchandising ought to be able to capitalize on potential benefits of these developments. Doing this successfully requires modernizing the appearance and functioning of the CBD shopping center. If major elements of the retail and other proposals made in the CBD plan are carried out, it is possible to realize a twenty percent, or $40 million, increase in total CBD retail sales by 1980. This will still be a somewhat reduced percentage of total future metropolitan retail sales, as sales in the metropolitan area are likely to double in the same period. The sales gain should be accompanied by some general reduction and consolidation of overall CBD retail floor space, to achieve a reasonable target level of productivity, or sales per square foot.

It was decided that effort toward planning for modernization should be concentrated on the central retail core, to emphasize the strengths and minimize the weaknesses of the whole complex. With a stronger core and greater pulling attraction, other parts of the retail community would also benefit. Principles of recent regional shopping center design were applied where they were relevant to the CBD retail core. It was determined that the jumble of individual stores must be subordinated to a unified design so that the shopper's impression was a pleasant one, suggesting that he or she was really in one large store, but with a great variety in detail.

Reinforcing the present pattern, there must be inexpensive, close, and adequate parking concentrated in large, easily accessible, self-parking structures. These parking improvements, combined with the real advantages the CBD has in mass transit, would provide the necessary convenience of access that such a large retail center requires. Analysis of existing pedestrian and vehicular traffic showed the need to separate the two to provide shoppers with unhindered

and safe movement between retail frontages. Service and delivery had to be hidden from view of shoppers, and made more efficient.

At first impression, applying these principles to the existing CBD retail core appeared impossible. The jumble of individual stores seemed to defy any unified design. However, real possibilities for creating a traffic-free pedestrian island are practicable if the main retail level can be changed to the second floor.

By closing one major street and several alleys, and by permitting the northbound streets to continue through, the pedestrian-island principle could be applied fairly extensively throughout the entire central retail core. The area would, eventually, be tied together by a series of second-level, interconnected walkways reaching over to Charles Center as well. The first floor would be devoted largely to service and access. This long-range plan of a second-level shopping center was never published as part of the final CBD plan, but served as a goal toward which short-range steps should point.

Instead, the proposal was made to create an air-conditioned mall with balconies, as the first step toward beginning the second-level system, over the main shopping streets at Lexington and Howard. By covering the streets, the ugly jumble of upper stores would be hidden from view. This walkway system would be carried into a new 1500-unit parking garage to supplement the existing 1500-unit garage immediately west of the shopping center.

The western portion of the east-west expressway ties the total 3,000-car garage directly into the expressway system a block and a half farther west. As a further supplement to the parking program, a substantial part of the 4,000 parking spaces in Charles Center will also be available for customer parking one block east of the main shopping center.

It was recognized that the actual development of this mall and additional parking would be dependent variables in the equation of downtown revitalization. Staging of them will properly come after Charles Center is under way. To carry the plan out, several devices are thought possible, one being a non-profit corporation to merge the interests of the various independent retailers into one shopping center complex.

Since announcement of the plan, considerable interest has been shown and a group of experts has been invited by the Committee for Downtown and the principal retailers to visit Baltimore and

advise on the detailed feasibility of the proposal. Many reactions, not all favorable, have come from retailers who see themselves not directly tied into the retail mall. However, in the long run there is little alternative for the central retail community, and it may prove to be in the city's interest to coerce the recalcitrants into line.

OPEN SPACE, PEDESTRIAN ISLANDS, LANDSCAPING

Consistent with, and corollary to the principle of intensive development is the principle of introducing open space, fundamental to carrying out the CBD plan. The open spaces themselves and the areas around them are treated as pedestrian precincts, or islands, free from traffic, within which pedestrians can move unhindered. Three of these islands are in Charles Center. Another pedestrian precinct, adjacent to Charles Center and tied to it by an interconnecting walkway system, will be developed as part of the rehabilitated central retail district.

Added to these pedestrian precincts will be small public squares between two major streets leading east from Charles Center into the municipal government complex. Finally, all of these pedestrian precincts and open spaces will be connected by a master landscape scheme that gives them structure, coherence and visual order.

The pedestrian islands are designed to eliminate traffic where it is clearly inharmonious with the function of retailing and pedestrian movement. They are not proposed in an indiscriminate or doctrinaire manner in strictly office districts or in segments of mixed use, where they would serve no useful purpose.

TRANSIT AN INTEGRAL ELEMENT

Obviously, transit service to the CBD, of vital concern to the plan, was an integral part of the city-wide picture. It was beyond the scope of the plan to analyze in depth such long-range problems as the economics of transit business, transit authorities, and new forms of movement. The relatively limited objective was to state the level of transit operation that could reasonably be maintained to support the various land uses proposed in the CBD plan and be consistent with the major traffic network. Unrealistically hopeful levels were discarded at the start.

Previous studies carried out in Baltimore emphasized the need to consider transportation as an integrated system—including

transit, highways and expressways as part of the whole. Fragmentary approaches to transit problems that require transit to be economically self-supporting in the face of large public expenditures to benefit its competitor, the private automobile, make certain its continued decline. The recent move in Baltimore toward creation of a mass transit authority is in the right direction, but it still falls short of a really comprehensive approach to the total transportation problem.

Whether or not the future needs of the CBD can be satisfied depends on successfully resolving the transit situation, and it is still too early to say whether that resolution is feasible in the foreseeable future. In the meantime, however, substantial improvements in the present transit system are being made to eliminate duplication of service, inadequate coverage, unwarranted transferring, and to realign routes to conform more closely with travel desire lines.

In 1958 the Department of Transit and Traffic issued three reports outlining many changes for express and local transit lines. The proposed system was incorporated in the plan as an integral part of the framework within which a more detailed CBD system could operate. These reports also emphasized the need for express service within the rapidly expanding metropolitan area.

In contrast to the all-day local service operation, data analyzed showed that present express service should be radically expanded to handle the peak hour demand—77.4 percent of the CBD bus-riding population arrives and departs during the 8 to 10 A.M. and 4 to 6 P.M. rush period. An examination of the place of residence of CBD-bound transit riders shows the potential market for express service. At the present time only 7.4 percent of CBD employees travel by express. These data also showed the increasing importance of CBD riders to the total transit system—45 percent as compared with 20 percent in 1942.

The Charles Center plan contained a proposal for a transportation terminal under the southern open space or park. This would be primarily an express bus terminal with additional facilities for out-of-town buses. As a temporary measure, until the terminal in Charles Center is built, a short, three-block street adjacent to Charles Center was designated for use as an interim express bus terminal.

Creation of the transportation terminal, realignment of express routes and the assignment of a high proportion of buses to express service—combined with the local system proposed by the Department of Transit and Traffic—from a consistent and adequate system, if carried out, to support the proposed land uses within the CBD. In addition to the local and express bus routes, a shoppers' bus route is already in operation tying together the retail core with the financial and governmental centers to the east, and the state office building area to the north.

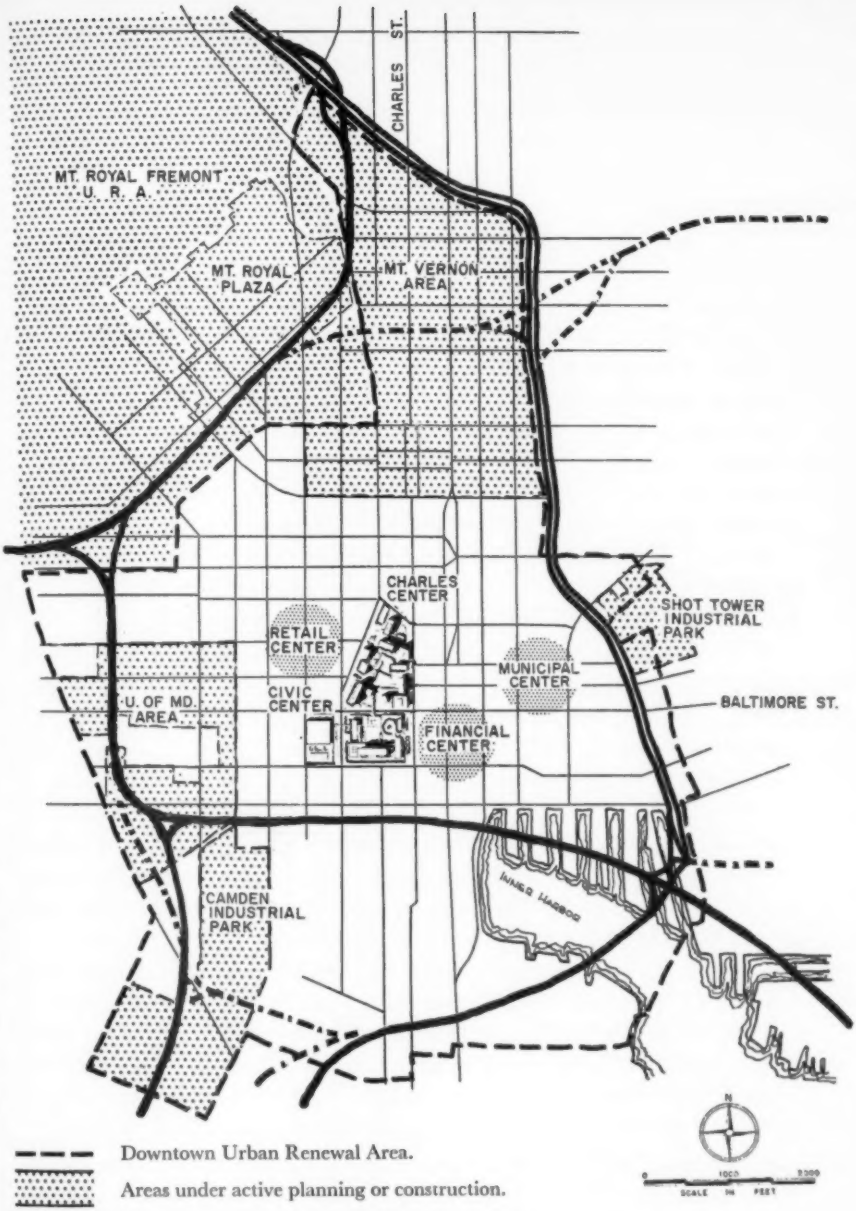
At the present time fifty-three percent of all 97,000 CBD employees travel by bus to and from work. With the kind of transit service proposed in the plan, it can be assumed as a reasonable goal that transit ridership to the CBD at peak hours will decline from forty-nine percent at present and stabilize at about forty-three percent by 1980. This estimate may prove too conservative if more radical improvements in transit are carried out. However, it recognizes the fact that the majority of the 20,000 additional employees envisioned in the CBD in 1980 will be located at the hub of the transit system where current transit ridership is highest.

The Baltimore Transit Company has indicated considerable skepticism toward the possibility of providing greatly increased express service in the face of declining revenue, without some form of city subsidy. However, a fundamental principle which is gaining wider currency in thinking about transit is based on a readiness-to-serve concept underlying a good deal of utility planning. Under this concept, any public subsidy should be related to the transit service necessary to serve various land uses adequately.

The fact that the actual ridership does not pay for this service should not mean that the service should be discontinued. The typical transit rider who travels two or three days a week by bus must share the cost of having the bus there when he wants it. This thinking conceives of transit in the same category as roads and bridges, constructed and maintained in only general fiscal relationship to actual users.

TRAFFIC RELATED TO LAND USE

The development of a balanced relationship between land use and traffic depends for validity on the assumptions regarding tran-



Downtown Urban Renewal Area.

Areas under active planning or construction.

Expressway, approved and under construction.

Proposed expressway.

Old expressway proposal.

Figure 2. Charles Center and the Urban Renewal Program.

sit, and later, on parking. Together, these constitute a functional model of the CBD. The traffic element of the CBD plan contains a composite of recommendations from organizations including the Departments of Planning, Transit and Traffic and Public Works. Combining these recommendations into an internally consistent and logical model has been done by applying certain fundamental principles.

The first of these was elimination of through-traffic from the CBD. Analysis of present and 1980 traffic showed that the capacity of present street systems, with the addition of the proposed expressway ring, would be adequate for the expanded traffic in 1980. The design of the expressway ring makes possible a system in which a large proportion of through-traffic can be diverted to relieve the CBD of its traffic congestion and permit the streets to perform their proper function of access and service, with some slight capacity to spare.

The second principle used in developing the CBD plan was that of maximizing efficiency of the entire street and expressway system by permitting a great flexibility of movement, rather than by trying to exclude all traffic in a doctrinaire manner. The CBD plan permits substantial traffic to flow around the pedestrian islands and properly serve the activities. Aside from the peak hour problem, it is believed that a central business district completely devoid of automobiles and dependent for internal transportation on taxis or other mechanical transportation would be both a barren environment and one in which proper servicing of the various land uses would become excessively complicated and costly.

With regard to the ring itself, analysis of the future traffic pattern by the Baltimore Regional Planning Council and the Department of Transit and Traffic has indicated the desirability of revising the 1949 inner-ring system as shown. This revision has been further indicated by vigorous, popular opposition to one of the elements of that inner-ring system. An alternative east-west route now being studied by the Department of Planning serves in providing much more directly access to both the retail core and the intensive Charles Center and office development areas. It may prove, on detailed engineering study, to be more desirable as well as more feasible.

Many alternative methods of handling traffic problems were analyzed. One theoretical extreme of excluding all traffic from the

CBD was rejected both for reasons mentioned above and because of the impracticality of arriving at idealized patterns from the present state of affairs in a mature central business district.

Another alternative reviewed and rejected was to eliminate all expressway ramps from the inner-ring system. This alternative was conceived because it became apparent that the proportion of traffic *through* and *to* downtown were about the same as the proportion of present CBD street-system capacity to that for the proposed expressway system. Theoretically, therefore, through-downtown traffic could be channelized on the ring system, leaving the present CBD street system for traffic destined for downtown. This plan would have meant, of course, that traffic from the suburbs approaching downtown would have to get off the expressway some distance from downtown in order to be fed into the downtown street system.

This alternative was advised against on the grounds it would reduce flexibility to the extent that the entire system would not be used to its maximum efficiency. Suggested instead was what has now been developed as the inner-ring system ramps providing excellent access and giving maximum flexibility.

PARKING FACILITIES IN THE CBD

In the final analysis, within a certain range the city can determine the relative roles that are to be assigned to the automobile and to public transportation. Each carrier must play its proper role to the greatest benefit of all segments of the population. Proposals for transit and traffic must be conceived as a part of the logical model of land use and the fourth element, parking.

The location of present parking garages forms two rings, one surrounding the Howard and Lexington Streets shopping core, and the other the offices of the financial district. Most of the larger garages lie on the north side of the CBD to intercept the heaviest incoming traffic volumes. Parking lots, on the other hand, are more uniformly distributed throughout the whole fringe area, with a fairly heavy concentration in the southwest quadrant. Location of facilities has been largely dictated by opportunities for easy land acquisition. The relation of parking facilities to the overall circulation system has not been particularly satisfactory.

After extensive analysis of the present parking situation, it ap-

peared that the principle of peripheral parking could be applied in the shopper area. In fact, it is already under way in the Charles Center plan. The addition of 1500 cars to the existing Lexington Market Garage is also consistent with this principle. These two facilities, with a 7,000 car capacity, closely conform to the latest thinking in regard to location of major parking ports between expressways and the shopper's destination. Rather than suggest a further consolidation and relocation of existing parking at the present time, it was believed that there should be a re-analysis after the first two large garages are constructed. In a longer-range plan results of such a study might indicate another large parking facility in the northeast quadrant of the CBD, tied to the Jones Falls Expressway.

It is estimated that future minimum off-street parking demand will require increasing the present supply from 15,600 to 31,500 spaces. The main difficulty in estimating long-range requirements is determining future division between CBD transit and auto-ridership. If estimates in the plan are not borne out by a vigorous program of support and redesign of the transit system, auto-ridership and parking demand in the CBD may reach suffocating proportions. Conceivably three times the existing number of spaces may be required, with a commensurate dislocation of land-use recommendations. Transit revitalization is critically needed if future off-street parking requirements are to be kept within reasonable bounds.

Relating parking needs to proposed land use to satisfy the parking requirements of new floor space, about 7,400 spaces are estimated as necessary by 1980. This figure is based on a conservative standard of one parking space per 1,000 square feet of office floor space, the standard used in Charles Center. Existing programs, including Charles Center, the civic center, the University of Maryland downtown campus, and the Mercy Hospital reconstruction, will add about 4,500 spaces net, leaving a 2,900-space deficit after current programmed construction in the plan is completed. For the remaining 3.6 million square feet of new office construction, at least 1,800 spaces could easily be provided by the buildings themselves, particularly if an off-street parking provision is incorporated in the new zoning ordinance now being devised.

Major elements of the renewal program for downtown—

Charles Center, the Civic Center, the University of Maryland Campus, the Shopper's Mall, parking, and the open space program —fit in as integral parts of the city's overall renewal strategy. Baltimore has long been a leader in urban renewal thinking and methods. It was the first city to see the need for completely reorganizing and consolidating the various activities and programs that make up the composite of urban renewal. In order to gear itself for this function, the city, in 1957, reconstituted its renewal activities under one agency called the Baltimore Urban Renewal and Housing Agency. This Agency has charge of the complete range of activities from total clearance to code enforcement and other conservation measures.

In the early stages of Baltimore's renewal activity, emphasis was on clearing the slums around the downtown area. That program logically fits as part of the overall program. A strong downtown will be a focus around which redevelopment in the peripheral areas can gain added strength. Eventually, this procedure would appear to suggest a successive renewal of the areas proceeding from the center outward, and following much the same pattern as that in which the city originally grew.

Currently, the agency is intensively studying the Mt. Vernon area immediately north of the CBD as a major tie between the Mt. Royal-Fremont area and Charles Center in the CBD. The agency is also engaging landscaping architects to design details of the open space program throughout the CBD.

SIX STEPS TOWARD ACHIEVING PLANS

With the realization of substantial portions of the CBD plan already well under way, reflection on lessons learned may be useful and timely. Many of these will be obvious, but always bear repeating as conditions that must exist for a city to cope with problems of today and the future.

The first is that to prepare—or administratively arrange for preparation—and to carry out an effective planning program, a city must be geared to the kind of relatively radical, urban renewal steps envisioned in this plan. Baltimore is not unique in its problems—but it is relatively unique in its ability and willingness to deal with them.

Second, there are large areas of activity in which the business

community must take full responsibility for shaping its own and the city's collective destiny. Failure to realize this on both the part of city administrations, as well as of business and civic leaders, has bogged down many a worthwhile program.

Third, co-operation between these two communities, the business and political leadership, must be continuous and give-and-take. It can recognize no party labels or boundaries. Small-time politics and unwillingness to share credit and areas of jurisdiction have no place where real progress is wanted.

Fourth, there is a growing role for the kind of planning that the Planning Council has been able to carry on. Serious consideration was given to hiring the Department of Planning, or an outside consultant, to do the planning for downtown Baltimore. It was believed that outside consultants would have done what they often do—hit and run. To the extent that this is so, they are frequently irresponsible in their planning—trying to see similarities in cities to make the application of formulae easier. The Mayor's ruling out of the Department of Planning was fortuitous in that it set in motion forces that brought about the Planning Council as a service agency for the community.

Fifth, with sufficient knowledge of the long run, developing a plan in calculated, short-range steps that lead to the long run, makes more sense than the visionary artists' concepts of the future of many plans. Such long range illustrative-site-plans pose too many alternative ways of proceeding, combine easily attainable goals in the same level of generality as theoretical ideals, and tend to confuse cities and laymen.

Sixth, proceeding with short-range achievable projects necessitates a clear underlying concept of planning and renewal strategy, with a well-working "feed back" system to review this strategy and recommend next steps as the plan progresses toward reality.

English Planner Views U.S. Traffic

ERNEST H. DOUBLEDAY

Mr. Doubleday has been County Planning Officer of Hertfordshire since 1947. He heads one of the leading planning teams in Great Britain and is responsible for planning this Home County on the fringe of London, with four new towns accommodating nearly a quarter of a million people, since the war ended. He is a Past President of the Town Planning Institute, a professional society operating under the favor of a Royal Charter from Her Majesty Queen Elizabeth II throughout the British Commonwealth and overseas. Mr. Doubleday is the founder-chairman of the Research Committee of the Institute and has occupied this position since 1948. He has traveled widely and has represented the British planning profession at international conferences in Lisbon, Vienna, Berlin, and elsewhere. At the request of the Rees Jeffreys Road Fund in Britain he carried out a study tour of American and Canadian traffic conditions in April and May 1959.

"I CAME, I saw, I conquered," reported Julius Caesar of his visit to Britain in the first century, B.C. For my visit to North America in the Spring of 1959 A.D. a slightly changed expression applies. I came, I saw and I was captivated—captivated by the way in which the North American continent was grappling with the effect of the motor car.

It would be presumptuous for an Englishman, on the basis of a two-month tour, to do less than praise what has been done in America under the name of traffic engineering. One's first reactions seek expression in the "stupendous," "colossal," "biggest-ever" vocabulary of the film world. Second thoughts search for simple words to contrast the bewildering, super-human, labyrinth of highways to which the North American people appear to be permanently committed.

On the techniques of traffic and highway engineering, none will question the right of American practitioners to the accolade. On the philosophy of what has been done, the Old World may perhaps be forgiven for looking askance at some things in the New, and wondering if it is not right to continue to search for solutions more in the human scale.

A single example of the car-dominated existence whose at-

tractions are called in question will serve to illustrate what to many eyes will seem to be the point of no return: the drive-in church.

AN ADDICTION TO THE MOTOR CAR

Whatever through the ages man has worshipped has evoked a respect, a reverence, a submission to a deity of some kind. In some religions, shoes are taken off, hats are removed, eyes are downcast, voices are lowered. In most, there is a close physical association of all levels of society, bared of their badges of relative material prosperity, congregating together as simple humans before their chosen symbol of deity. That such a corporate act, expressive of the very fount and object of man's life, should now be streamlined, like a chore, into a slick efficiency of gears and gimmicks, highlights the addiction of a people to the motor car.

This addiction is something that has developed at lightning speed, seen against the slow, gradual development of cities. Towns are organic, in that through the centuries some parts grow and flourish for a term, whilst others decay. A whole long series of factors have made their impact—wars and floods, street cars and overhead wires—but the town has still been recognisably the same sort of man-made settlement. Its character, function, size and prosperity have undergone changes, but the basic form and arrangement of streets and footways, homes and workshops have remained as identifiable descendants of their predecessors.

This must be, as the relatively unchanged physical environment reflects the relatively unchanged way of life. Into this harmonious, leisurely, evolutionary process crashes the motor car and demands uncompromisingly that to accommodate its needs the town should, in the twinkling of an eye, turn itself inside out in a series of quick-change acts that will completely transform it.

A WARNING

Our towns manifest civilized living as we know it. What is now demanded is that we sweep all this away and give the demolition gangs a free hand to erase the evidence of centuries of comely settlement just to satisfy the whims of today's toy, a tyrant whose demands tomorrow may be more exacting.

To British eyes, what is happening in America as a result of

invasion by the motor vehicle is a dire warning. We have a lurking suspicion that all we have been doing in Britain amounts to no more than a palliative, a whole series of temporary expedients—in traditional fashion we hope somehow to muddle through. We know that our "No Waiting" regulations, our unilateral parking arrangements on the highway, our "Halt" signs and our roundabouts are little more than the evidence of an outlook that has perforce, since hostilities ended in 1945, had to be tied too long to a period of economic stringency.

These restrictions are pain killers, tranquillisers, a whole medical dictionary of traffic sedatives to damp down the symptoms until we are financially able and willing to face hard traffic facts. Fortunately there is evidence with our new motorways that we are at last moving in the right direction.

BOA CONSTRICTOR TRAFFIC

But in America the visitor sees traffic sickness at a much more advanced stage than in his own country. Sedatives have only been partially successful and more decisive action has followed. A bewildering series of major and minor operations on the city has been undertaken. Varicose traffic arteries have been by-passed, a city's heart has been massaged as traffic congestion squeezed the life out of it, television traffic eyes and artificial traffic counting-ears replace their natural forerunners.

Some American towns appeared to me to have successfully solved their traffic problems by ingenious physical solutions but in so doing had, to my professional eye, almost ceased to be towns for living at all. It gave pain to see the old concept of the town having the richness slowly squeezed out of it in the boa constrictor coils of trafficways.

I will return to this point later in this article for it is possible that our British experience may have something helpful to offer on the physical side of urban development and traffic control.

Let me here, however, refer to a couple of things that impressed me during my North American tour. In this article I can only do this in a general way for it is quite impossible to list the many things that fascinated me even though I was not always convinced that the right answer had been found.

First, the personal discipline of the North American people as motorists or as pedestrians seemed to me to be much better than in Britain, or for that matter in Europe where I have travelled thousands of miles on all kinds of roads. This discipline is indeed something to be emulated when one considers the scale on which modern motor traffic has to be accommodated.

FOUR-LEVEL INTERCHANGE

Next, my outstanding impression on roads is the size and scope of the vast California state highway programme. What struck me as remarkable was that practically the whole of the programme so far carried out has been undertaken since 1945. The highlight, of course, is the four-level interchange on the Hollywood Freeway in Los Angeles; brilliantly conceived and executed, and ruthlessly efficient in practice. I still find it hard to convince my countrymen that this interchange handles 400,000 vehicles a day, or more than twice the designed capacity.

More in the human scale I was charmed by the landscaping design of the Merritt Parkway on the Connecticut highway system. This Parkway, with its earlier connections in New York State, the Bronx River and Westchester Parkways, handled considerable volumes of urban traffic without subjugating the surrounding terrain to the dictates of the "monster on wheels."

This last point, I regret to say, is not always kept in the foreground by highway engineers when designing their programmes. I felt very sad to see the North Shore of historic Boston dominated by miles of three-tiered steel bridgework, likewise parts of lovely San Francisco—a sadness still felt at the time of writing this article on the other side of the Atlantic. Could this not have been avoided by co-operation between the city planner and the highway engineer? Was this the only way to handle the traffic? How long will it take the surrounding areas to recover? These are the kind of questions that continually come to mind and cause uneasiness.

TRAFFIC CONTROL AND LAND USE PLANNING

That I am not alone in this uneasiness was demonstrated by the Sagamore Conference on Highways and Urban Development held in Connecticut in January 1959 with its specially convened partici-

pants. The main conclusion of that conference to which I now refer is that where there is an overall urban development job to be done, this requires the best thinking and co-operative teamwork of a number of kinds of specialists.

What seemed strange to me, as a visitor, about the American approach to the motor car was this relative divorce between traffic control and flexible land use planning. I found no lack of knowledge of the vital factor of land use planning in your professional ranks; my personal contacts in North America prove this. The knowledge is there, but the legislation to shape and apply it is missing and the administrative links seemed not as strong as they could be.

The best example of co-ordination between planner and traffic engineer was to be found in Vancouver, but even here the lack, by British standards, of legislative power was noticeable. American zoning ordinances prescribing the use, density and mass of buildings, the standard of parking facilities, the fire restrictions of each street block, are evidence that the elements are widely known. But do they go far enough and are they applied in the best way?

In Britain, we have these controls too as details to be applied when the overall land use pattern, based on adequate researches, and tested by the fire of public criticism, has been approved by the Minister responsible to Parliament for town and country planning.

WHERE PROCEDURES DIFFER

It is perhaps from this point onward that the differences between the procedures in the two countries are most marked. As I understand zoning procedure in America, when a piece of land is zoned for a particular use—say industry—that is, broadly speaking, the limit of control over its traffic-producing potential.

In Britain, on the other hand, that point is merely a stage in the process, *inter alia*, of tailoring the traffic produced by that land to the capacity of the surrounding highway network. "Industry" is for us far too loose a description of land use to obtain effective traffic control merely by zoning. It embraces with undiscriminating ease the industry that spreads over acres of land, using vast areas for storage and processing and yet employing comparatively few workers. At the other extreme, the term "industry" covers an aircraft plant with a high density of workers and a car for each of them,

causing heavy traffic flows to and from the factory at certain times of the day.

In Britain, therefore, a zoning for industry merely gets a particular firm a first hearing. When we have assessed its likely effect on the traffic pattern, the balance of employment, the pollution of the air, the demands on water supplies and power plants and many other factors, then only does it become clear whether it can be accepted on that site. This is an overall approach to land use and gives a flexibility to the local development plan, enabling it to admit what can be accommodated and yet reject something which, whatever its general description, would at that point, at that time, be wrong planning.

SUBJECT TO APPEAL

The local planning authority's decision is, of course, subject to an appeal to the Minister, whose Inspector holds an Inquiry into the merits of the case. The report of the Inspector on the Inquiry facts are available to any interested person when the Minister has made his decision, which is final. In this way, case history and public knowledge thereof are continuously built.

Perhaps I may be forgiven if I say that the British practice does prevent a situation's arising where the first that the highway engineer hears of a factory development is when traffic begins to pour out on to the main highway, as indeed many of my professional friends told me can and does happen under the zoning controls of both America and Canada.

In urban areas in Britain needing redevelopment, the local planning authority has to define, on its "comprehensive redevelopment plans," details of the proposed new land use of the area, e.g. residential, commercial or industrial, together with the line and character of the new traffic routes through the area. These plans are subjected to public criticism, with modifications if needed, before the plan is sent to the Minister for approval, which is generally not forthcoming until a Public Inquiry has been heard. All this can take several months to complete. By this means, however, the local planning authority initially and the Minister finally, are able to assess the views, frequently conflicting, of business, industrial and residential interests as well as amenity considerations often strongly voiced by able local enthusiasts.

'SLOW BY AMERICAN PRACTICE'

This method may be considered to be slow by American practice, and indeed it is, but the final outcome is one which takes into account all interests, large or small, economic or aesthetic, and does not subjugate any one of them to ruthless dictation.

I could not help wondering, when in San Francisco, whether the resistance of residents in the Golden Gate Park area to the proposed extension of the expressway through their district did not stem from lack of opportunity to present their views at an earlier stage. The British system of planning allows for just this opportunity, and after fifty years of trial and error we have found it worthwhile to take a little longer overall to allow fresh ideas to be put to the test of public criticism, modified as thought fit in the light of that criticism, before the plan is approved and the bulldozers get to work.

I would be the first to admit that a new testing time is at hand for the British redevelopment practice. We have not the gridiron pattern of street layout in our cities on which practically all North American cities have developed. Consequently, a whole length of street blocks cannot be pulled out of the town centre, as happened in Detroit to make way for the remarkably efficient John Lodge Expressway at a lower ground level. We will need to be particularly careful, with American standards of grade separation before us, that we tailor these new traffic routes to the individual pattern of our cities.

FREEDOM EXERCISED WITH TOLERANCE

It is perhaps fortunate for us that through redevelopment schemes for "blitzed" areas, we already have had several years' experience of planners, highway engineers, land valuers and architects working as a team within our legislative code and contributing their skills to the best redevelopment scheme possible.

On several occasions when explaining our British planning practice, my American friends replied, "Oh yes, but the American believes in his freedom to do what he wants." These replies sounded strange to an Englishman to whom anything less than freedom for the individual is objectionable. In Britain this freedom, however, is exercised with tolerance and respect for our neighbour's point of view, even though we may not agree with it. This is demonstrated

quite clearly by a willing acceptance—far transcending our narrow party political allegiance—of a well tried land use control system that is essential to our individual and corporate life.

Americans freely adhere to a code of individual conduct on the roads far exceeding our own in strictness, yet they stop short of translating this self-discipline into a collective and flexible land use code governing the places that generate traffic.

Why this should be so is difficult to understand. Perhaps the reason is that the Continent, with its challenge to man and machine, is so vast that in the glorious and commendable flush of individual achievement, the inevitable gradualness of collective needs remains yet to be discovered.

Influence of Connecticut Turnpike in Diverting Parallel Route Traffic

EARNEST W. ELLIOTT AND FRANCIS E. COLEMAN

Mr. Elliott is an Associate Highway Engineer in the Planning Division of the Connecticut Highway Department. He is in charge of long range programming, highway needs, planning research, records and statistics. Mr. Elliott is a graduate of the Yale Bureau of Highway Traffic (1956) and an associate member of the Institute of Traffic Engineers. Among other assignments, he served as Chief Planner and Director of a federal civil defense project in which he supervised the development and preparation of a wartime operations plan for the State of Connecticut.

Mr. Coleman is in charge of planning research in the Planning Division of the Connecticut Highway Department. He is a graduate of the Yale Bureau of Highway Traffic (1958) and a member of the Connecticut Society of Civil Engineers.

THIRTY-FIVE years ago, traffic volumes on US 1 along the Connecticut shore through Fairfield and New Haven Counties reached sufficient proportions to cause citizens and officials alike to seek relief measures. Many plans were advanced; however, it was not until some fifteen years later that the problem was at least partially solved by construction of the Merritt Parkway.[1]

The Parkway was constructed as a four-lane expressway toll facility, roughly parallel to and three to five miles north of US 1. Almost immediately, one-quarter of the US 1 passenger cars were diverted to the Parkway and US 1 conditions once again became tolerable. In subsequent years, traffic continued to increase on both facilities until, by the mid-1940's, congestion again prevailed on US 1.

In 1943, Special Act 365 of the General Assembly authorized the Highway Commissioner to lay out and construct a parallel facility to US 1 between the New York State line and the Housatonic River in Stratford. In compliance with the Act, field surveys were

1. To simplify nomenclature, the section of the Wilbur Cross Parkway between the Housatonic River and New Haven, a continuation of the Merritt Parkway, is also referred to as Merritt Parkway.

begun. However, in 1945, the Legislature amended the Act to permit planning only. In 1947, the Act was repealed in its entirety.

In 1946, the Connecticut Highway Department indicated that the predominant need in Fairfield County was the relocation of US 1 and its construction as an expressway-type facility.[2] However, the then current five-year program (1945–1950) gave no priority to any part of it.

Between 1946 and 1951, the Connecticut Highway Department made several studies[3] for improvements of US 1 in individual towns. In 1951, the Legislature passed Special Act 235 which once again authorized the highway commissioner to plan, lay out and construct a highway in Fairfield County to relieve traffic congestion on US 1, and a study[4] for the solution of the US 1 problem was again undertaken.

In 1953, the General Assembly, by Special Act No. 3, directed the construction of the Greenwich-Killingly expressway, later designated as the Connecticut Turnpike. Construction was started in 1954 and the Turnpike was officially opened to traffic on January 2, 1958.

The Connecticut Turnpike consists of a barrier-type toll expressway with full control of access. It traverses the Connecticut shoreline towns from the New York State line at Greenwich easterly to East Lyme, thence northeasterly to the Rhode Island State line at Killingly, a total distance of 129 miles. Its facilities include ninety-one interchanges, eight barrier-type toll stations, seven pairs of service stations and four restaurants.

The Turnpike traverses twenty-eight towns and cities including Stamford, Norwalk, Bridgeport, New Haven and Norwich. Between Greenwich and New Haven, it is predominately a six-lane expressway through some fifty miles of highly urban area. The highway and interchange locations were based primarily on area service, not for toll revenues. East of New Haven, the Turnpike constists of four lanes through principally rural areas.

The Turnpike was planned, designed and constructed to relieve traffic congestion on US 1; however, it was anticipated that its

2. *Connecticut's Road Program*, Connecticut Highway Department, November 1946.

3. *US 1 Norwalk—Recommended Improvement*, Connecticut Highway Department, May 1950. *US 1 Bridgeport Area*, Connecticut Highway Department, January 1951.

4. *Solution to the Post Road Problem*, Connecticut Highway Department, February 1952.

influence would be felt on other parallel routes also. The extent of this influence in diverting traffic to the Turnpike from other parallel routes has been measured through a simple "before" and "after" study.

METHOD AND SCOPE

For comparative purposes, the shoreline corridor traversed by the Turnpike and its parallel routes was divided into two study sections as shown in Figure 1. In Section I between Greenwich and New Haven, the Turnpike's diversionary effect upon parallel routes US 1 and the Merritt Parkway was studied. In Section II between New Haven and Old Saybrook, the Turnpike's effect upon parallel routes US 1 and Conn. 80 was studied.

The Turnpike's influence on traffic diversion east of Old Saybrook to the Rhode Island State line was purposely omitted since there are no suitable parallel routes for which data are sufficiently complete to permit a valid comparison.

A "before" situation was determined for each route in each town traversed by the Turnpike, by expanding the average daily traffic volume that existed prior to the construction of the Turnpike to a theoretical 1958 average daily traffic volume that would have existed had the Turnpike not been constructed.

An "after" situation was determined for each route in each town traversed by the Turnpike based upon average daily traffic volumes measured since the opening of the Turnpike.

Since the routes studied constitute all the major parallel facilities, the difference between before-and-after average daily traffic volumes is assumed to constitute the volume of traffic diverted from the routes concerned to the Connecticut Turnpike. Actual volume differences have been converted to percentages of diversion by route and by town for comparative purposes.

In the computation of before-and-after volumes, fluctuations in volumes along a given route, due to intersecting streets, necessitated the selection and use of representative locations within specific segments of highway. From the known length of each segment and the known average daily traffic for the segment, a weighted average daily traffic volume was derived for both the expanded 1958 traffic had the Turnpike not been constructed, and the actual 1958 traffic.

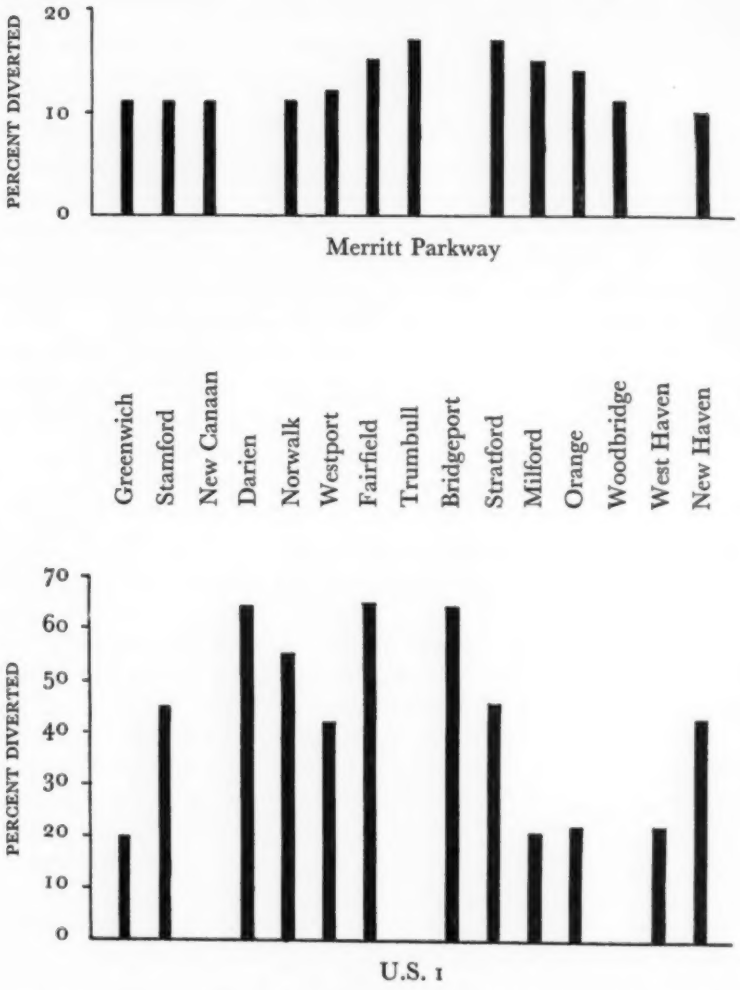


Figure 2. Percent of 1958 traffic diverted from U.S. 1 and Merritt Parkway to the Connecticut Turnpike.

On US 1, "before" volumes were based upon counts made in 1955 expanded to a theoritical 1958 average daily traffic using an average growth factor for the area. Although more recent counts were available, they were not usable since construction of the Turnpike disturbed normal traffic patterns. "After" volumes were obtained from extensive counts made in 1959 adjusted downward to a 1958 volume figure. A permanent automatic-recorder station on US 1 in Westport and a manually operated key station on US 1 in Greenwich served as the major controls for both "before" and "after" figures, supplemented by drawbridge-operator counts and numerous portable traffic-recorder counts along US 1.

On the Merritt Parkway, automatic counters at the Greenwich and Milford toll stations provided controls which, when supplemented with extensive counts made in 1955, furnished both the theoretical and actual 1958 average daily traffic.

On Conn. 80, extensive counts made in 1955 were expanded in accordance with the pattern from a manually operated key station on Conn. 80 in Guildford.

BEFORE-AND-AFTER FIGURES ANALYZED

In Section I, Greenwich to New Haven, the percent of 1958 average daily traffic diverted from US 1 and the Merritt Parkway to the Turnpike is shown by towns in Figure 2.

On US 1, the percent diverted ranged from twenty to sixty-five percent with an arithmetic mean of forty-two percent and a standard deviation of seventeen. Although the dispersion is relatively wide, it can be partially explained by the fact that the close proximity of US 1 to the Turnpike, combined with barrier-type tolls, permits free local and semi-local trips—thus encouraging use of the Turnpike's superior facilities to those of US 1 for short trips. The same reasons may account for the larger percent of diverted traffic in many towns.

On the other hand, the proximity of toll stations and the apparent ease with which some can be bypassed may influence route selection by local and semi-local traffic and account for the lower percent of diverted traffic in other towns. The Greenwich toll station on the Connecticut Turnpike is located near the New York State line. One might expect US 1 traffic in Greenwich to decrease

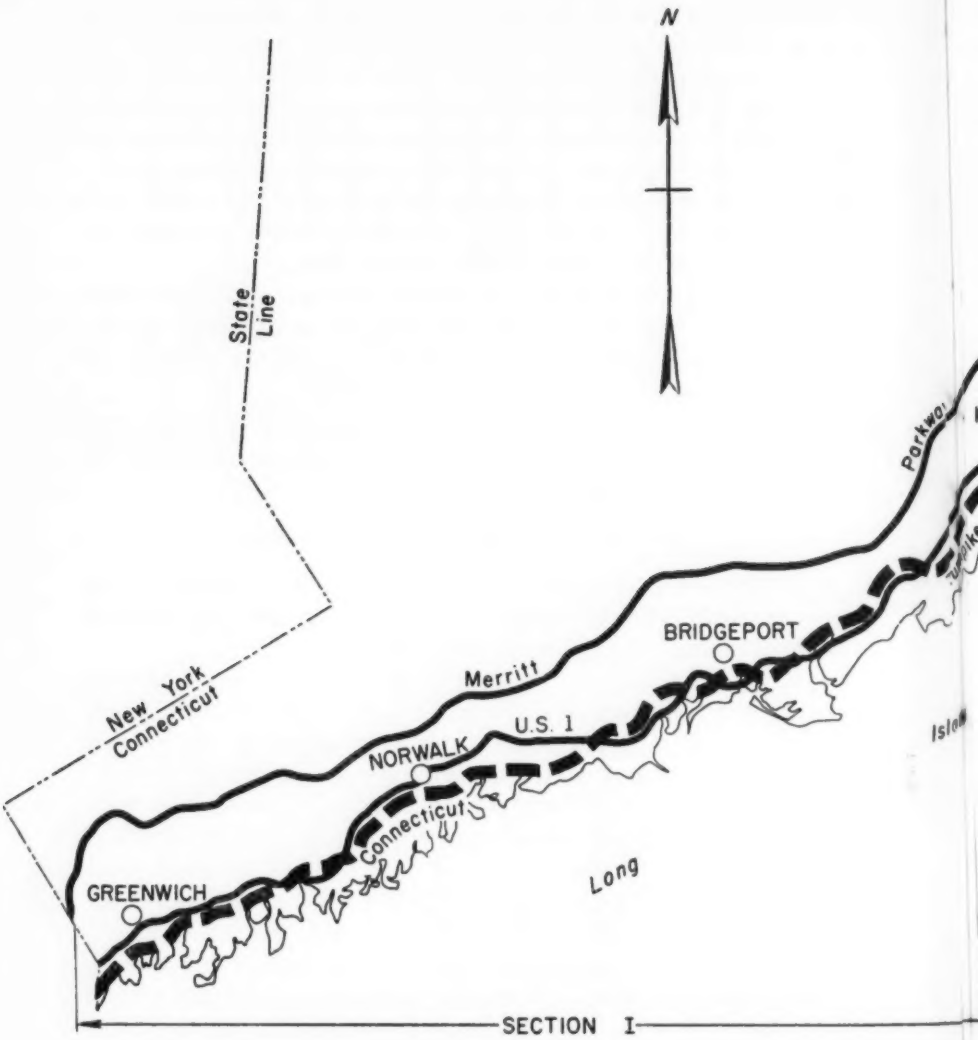
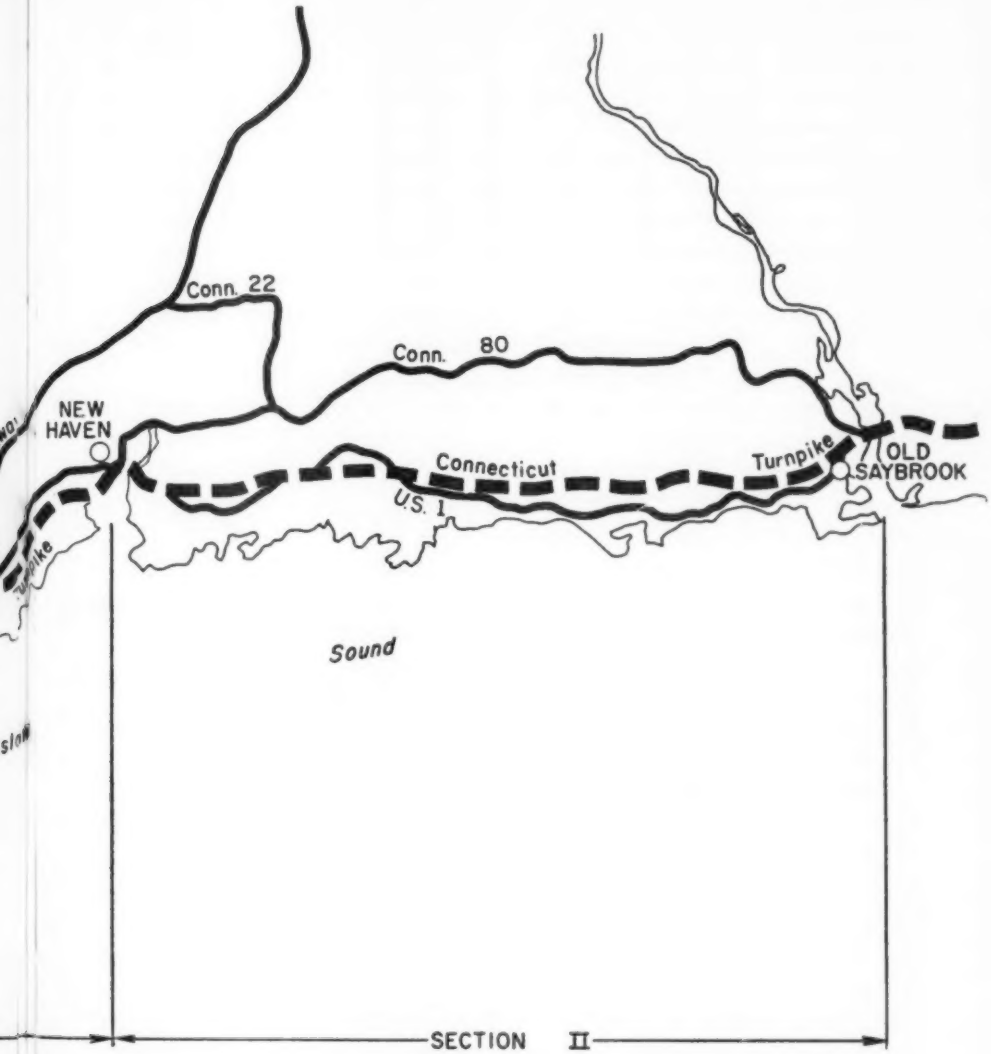


Figure 1. Connecticut Turnpike and parallel routes.


Conn. 22
Conn. 80
NEW HAVEN
Connecticut
Turnpike
OLD SAYBROOK
U.S. 1
Sound
SECTION II

only slightly because of the toll station and, at first glance, the twenty percent diversion might indicate that such an assumption was valid. However, the Byram River Bridge connecting the Turnpike to New York's New England Thruway was not opened to traffic until October 1958. Thus, through-traffic as well as local traffic was forced to use US 1.

On the Merritt Parkway, the percent diverted ranged from ten to seventeen percent with an arithmetic mean of thirteen percent and a standard deviation of two and a half. It is believed that through- and commuter-traffic uses the Turnpike in preference to the Parkway not only because it is a superior facility but because it is a part of the federal interstate system and connects with the New England Thruway in New York. It is also likely that some of the commuter traffic that previously used the Merritt Parkway to avoid congestion on US 1 now finds it more convenient to use the closer Turnpike facility.

In Section II, New Haven to Old Saybrook, the percent of 1958 average daily traffic diverted from US 1 and Conn. 80 to the Turnpike is shown by towns in Figure 3.

On US 1, the percent diverted ranged from twelve to sixty-two percent with an arithmetic mean of thirty-eight percent and a standard deviation of fourteen. Again, the dispersion is relatively wide and can be partially explained by reasoning similiar to that applied to US 1 in Section I. For example, the small percentage of diversion in East Haven can be attributed to "by-passing" of the Branford Toll Station by New Haven commuters.

Between New Haven and Old Saybrook, Conn. 80 provided a faster trip than US 1 because of the former's almost completely rural nature. Prior to the opening of the Turnpike, Merritt Parkway traffic traveling east of New Haven was routed around New Haven on the Parkway to Conn. 22 in North Haven, thence to Conn. 80. Therefore, some through-traffic was encouraged to use Conn. 80. Commuter traffic also used Conn. 80 where it was convenient to avoid congestion on US 1. The percentage of diversion for Conn. 80 ranged from thirty-four to thirty-nine percent with a mean of thirty-six percent and a standard deviation of two. Owing to the Turnpike's superior facilities, this amount of diversion was expected.

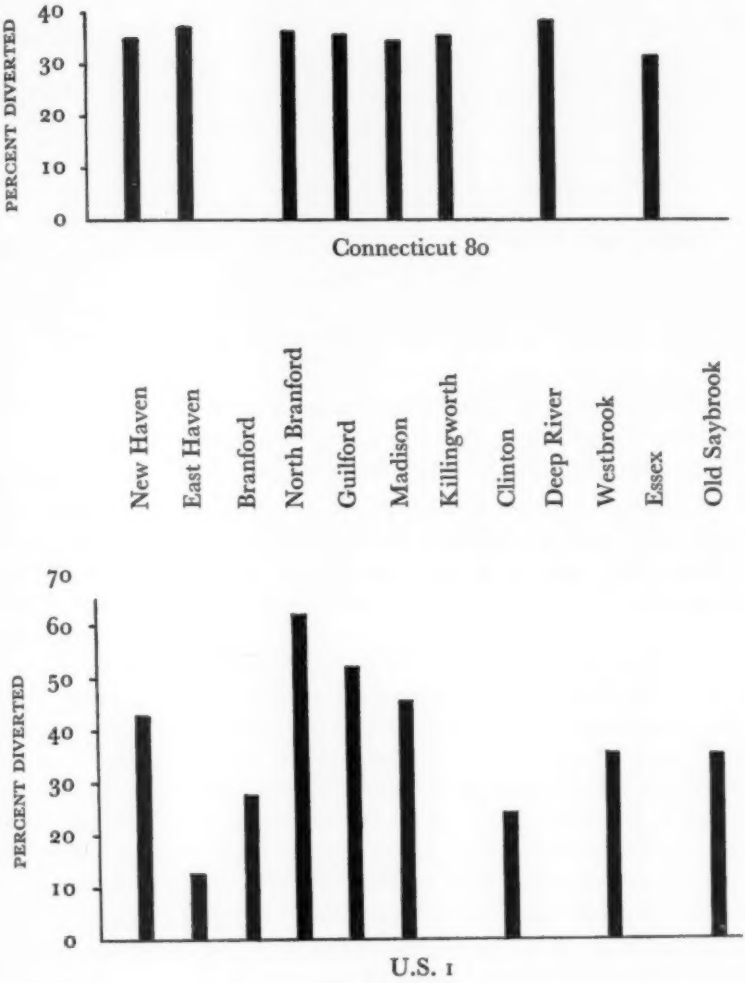


Figure 3. Percent of 1958 traffic diverted from U.S. 1 and Connecticut 80 to the Connecticut Turnpike.

The deviation of the mean is not as great for the Parkway and Conn. 80 as it is for US 1, because of the stable character of the former routes through rural areas, as compared with the wide fluctuations occurring in urban areas on US 1. The frequently close proximity of US 1 to the Turnpike, plus the many fricitional and impeding factors on US 1, results in many motorists' using the Turnpike in preference to the city-street nature of US 1, even for short intra-city movements.

INCREASING TURNPIKE USE

The influence of the Connecticut Turnpike in diverting traffic from parallel routes is summarized as follows:

Section	*Route*	*Percent of 1958*	*Traffic Diverted*
		Range	*Mean*
I	US 1	20—65	42
I	Merritt Parkway	10—17	13
II	US 1	12—62	38
II	Conn. 80	34—39	36

Subsequent to the 1958 traffic figures, automatic counters at toll station facilities indicate the folllwing percentage changes for the first seven months of 1959 over the corresponding seven months of 1958:

Toll	*Merritt Parkway*	*Connecticut Turnpike*
Greenwich	30 percent decrease	71 percent increase
Milford	18 percent decrease	
Stratford		55 percent increase

It is recognized that a considerable portion of the current increase in Turnpike traffic is generated traffic. However, the continued decrease in Merritt Parkway volumes indicates that the trend toward greater relative usage of the Turnpike and a proportionately lesser use of the Merritt Parkway, US 1 and Conn. 80 is continuing, and that the percentage of diversions indicated herein may subsequently increase.

Automatic Parking Devices

GEORGE A. DEVLIN

Since 1937, Mr. Devlin has been Vice President in charge of the consulting and planning division of National Garages, Inc. of Detroit, Michigan. National Garages has been a pioneer in design, financing, and operation of self-service parking lots and garages throughout the United States and Canada. Mr. Devlin personally did much of the early development work on automatic ticket-issuing machines and coin- and gate-control equipment. He is a member of the Executive Group of the Central Business District Council of the Urban Land Institute, and the Board of the National Parking Association. He is a past member of the Transportation and Communications Committee of the United States Chamber of Commerce.

CONTINUALLY increasing wage rates have made it imperative to reduce manpower requirements in the operation of parking facilities. Widespread adoption of customer self-parking during the last five years has effected a seventy-five percent savings in wages through elimination of car "jockeys." Functions such as giving out tickets, directing the customer to an available parking space, and collecting the parking fee, however, remain even in this type of operation.

Recently a number of mechanical and electronic devices have been developed and offered to the parking industry. They have been aimed at further reduction in manpower, and greater efficiency in revenue and traffic control. A brief description of the more significant among these mechanisms, their function and application, follows.

THE PARKING METER

No discussion of this subject would be complete without mention of the parking meter—first and still the most common device used in the control of parking. Meters have been used extensively by most municipalities to regulate and collect a fee from the user of on-street as well as many municipally owned off-street parking facilities. Since the effectiveness of the parking meter is dependent on the unique privilege of a municipality to impose, through its

police powers, a summary penalty for violation of the parking ordinance, it has not found any application in the operation of privately owned parking facilities.

ELECTRIC GATE CONTROL

In its simplest form, this device consists of an electrically operated gate arm, similar to a railroad crossing barrier, installed on a single driveway serving both the "in" and "out" traffic of a small lot or garage. The arm normally is in the closed position. On the street side of the driveway in front of this arm and on the driver's side is a coin box similar to that used in vending machines.

To enter the parking facility, the driver deposits the required coins into the box, which, in turn, causes the arm to be raised, allowing the car to enter. A treadle in the driveway beyond the gate is actuated by the car as it clears the driveway, causing the arm to return to the normally closed position. When a car leaves, the crossing of the inside treadle causes the gate to open and a second treadle on the street side of the gates causes the gate to close after the car has cleared.

In more sophisticated versions of this same device, there are separate drives for incoming and outgoing traffic with two gates on each driveway—the first gate being normally open and the second gate closed. As the car goes through the drive, the first gate closes behind the car and the second gate opens in front of it, and after the car has cleared the driveway, the gates revert to the original position. This system provides absolute assurance that a car can pass through in one direction only.

In some installations, the car is permitted to enter without the deposit of coins, but in order to leave, the gate must be actuated by payment of the proper fee. In situations where it is desired to limit the use of the facility to specific customers, actuation of the gate upon entering is accomplished by insertion into the control box of a key, magnetically imprinted card, or token, which is issued only to authorized users.

Parking facilities controlled by a gate mechanism require no attendant. The system is used to a considerable extent in the regulation of private parking facilities serving hospitals, office buildings, universities, and apartment houses, as well as many public parking

lots catering to all-day customers at a fixed fee. The gate with coin actuation has also found some application in transient facilities where it is used after normal hours to collect a fixed fee from those who stay after the cashier has left, as well as to collect from the occasional off-hour parker.

PRE-COLLECTION AND RECEIPT-ISSUING MACHINE

This machine, placed at the entrance of a parking facility, issues upon payment of a specified fee a serially numbered receipt to an incoming customer. The customer is then required to place this receipt on the inside of the windshield, where it can be seen from the outside, thus providing the operator with a means of periodically checking the facility to see that all cars parked thereon have paid.

Any vehicle not displaying a receipt is presumed to be unpaid for and the operator can take appropriate steps to collect from the owner. In this latter respect, the system is similar to the function of the parking meter but without any elapsed-time control, and is an improvement over the "honor system" in that it provides a means of auditing receipts before the vehicle has been taken out. It is generally applicable to fixed-fee type operations.

AUTOMATIC TICKET-ISSUING MACHINE

Consisting essentially of a cabinet for storage of a continuous strip of parking tickets, a feed mechanism, a timeclock, a cut-off shear, and an actuating treadle in the driveway, the machine is mounted along side of the entrance drive to a parking facility (generally self-service). It issues a time-stamped, dated, and serially numbered ticket to the driver of each incoming vehicle, and therefore performs the same function as that of a doorman. Upon leaving a facility, the customer presents the ticket to the cashier for computation and payment of the parking fee.

This system has received rather enthusiastic acceptance by the general public, since it assures the customer that the time imprinted on the ticket exactly coincides with the time of bringing his car into the facility. This was not always true in the case of manual ticket issuing, as the attendant frequently stamped up ten or more tickets in advance and then handed them out in the driveway as cars entered.

The method has found its principal application in high-volume self-service type parking facilities having graduated parking fees, such as those associated with downtown department stores, retail centers, autobanks, airports, etc. Since in most installations the actuating treadle is placed about a car length in front of the ticket machine, the ticket is already cut off and presented through an opening in the machine to the customer by the time he gets opposite the machine, so that he has merely to reach out of the car window and withdraw the ticket without having to stop.

In actual operation, it has been demonstrated that a single entering drive equipped with such a machine can accept up to fifteen cars a minute, or somewhat more than twice as many as can be achieved with manual time-stamping and handing the ticket to the customer. Automatic ticket machines have also effected sizeable economies in situations where multiple entrances are desired, and in small facilities where it is impracticable to have the entrance and exit drives close enough together to permit one attendant to both issue tickets and collect the parking fees.

DIFFERENTIAL COUNTER

To insure that the customer takes the ticket, it has been found desirable in some installations to combine the ticket-issuing machine with an electrically operated gate barrier similar to that used in coin- and gate-controlled facilities. The gate is placed just beyond the ticket machine and connected to the machine in such a manner that, when the customer takes the ticket from the machine, the gate arm is raised, allowing the car to proceed into the facility, and upon clearing the gate, a treadle in the drive path causes the gate arm to return to the normally closed position. Also, where the entrance is not under continuous supervision by personnel, the addition of a gate in connection with the ticket-issuing machine is frequently necessary to prevent cars from leaving by the entrance drive. The use of a gate with the ticket machine reduces the rate of acceptance by a factor of about forty percent.

This is simply a digital add-and-subtract counter with visual numerical display actuated by electrical impulses derived from treadles or other devices located in driveways of a parking facility. In normal application, it is used to display a continuous inventory

of car accumulation within the facility. Figures are obtained by feeding a pulse from the sensing device in the entrance drive to add a count each time a vehicle enters, and from another sensing device in the exit drive to subtract one count each time a vehicle leaves.

The differential counter is finding wide-spread application, particularly in self-service parking facilities, to inform the operating personnel of the number of available spaces at any given moment and when to stop accepting cars when the facility has become filled. In those facilities using automatic ticket-issuing equipment, the incoming pulse for the differential counter is usually taken directly from the ticket machine. The subtracting pulse may be taken from the cashier's check-out clock instead of from a sensing device in the exit drive.

In certain more elaborate installations, totalizing counters are also included: one that records the total number of cars in, and the other the total number of cars out. In still more sophisticated installations, the differential counter is connected so as to turn on automatically a "full" sign, or lower a barrier across the entrance when a certain pre-set accumulation of cars has been reached, usually the total car-capacity of the facility.

It has been found, however, in the actual operation of large high-turnover facilities, that the differential counter can be set to close off the entrance after an accumulation of approximately ten percent more when the total capacity of the facility has been reached, the ten percent overload being represented by cars in transit within the facility. Differential counters are almost mandatory in coin- and gate-controlled facilities to prevent cars from entering when the parking area is filled to capacity.

Differential counters have also been successfully used in large multilevel facilities or large parking lots, which are divided into various sections, to indicate to the operating personnel, or by appropriate signs to the parking customer, whether parking space is available on a particular floor or section of the parking lot. To date, the use of differential counters in the large surface parking areas associated with shopping centers has been quite limited. Their use in such facilities would appear to have considerable merit in reducing congestion and unnecessary circulation during peak load periods.

Such installations consist of an Iconoscope mounted on a centrally located tower to scan a large surface parking area. The image received is transmitted by wires to a viewing station, usually near the entrance, to assist the attendant in directing parking customers to an available space. The effectiveness and economics of such installations have not yet been generally tested. However, in certain instances, one or more attendants have been eliminated through the use of this equipment. This device cannot be used effectively in multilevel facilities where low headroom limits the scope of the scanning unit.

CLOSED CIRCUIT TV

Most automatic parking devices depend for their operation on some sort of sensing unit activated by the presence of an automobile. There are many types of these units on the market today, none of which has proved entirely satisfactory.

The simplest and most inexpensive is the rubber tube type treadle. It is usually surface-mounted across the driveway and operates to close an electric circuit when the wheel of an automobile passes over it. In some types, the contacts are actuated by a pressure switch's picking up the increased air pressure within the hose when it is compressed by a wheel; in others, the circuit is closed merely by the contact of two wires within the hose when it is flattened under the tire pressure. The principal disadvantage of the hose type treadle is that it can be actuated by a person stepping on it. It is, therefore, susceptible to many false actuations when installed in driveways that are also used by pedestrians.

SENSING DEVICES

These units also have the disadvantage of giving two impulses, one from the front wheels and one from the rear wheels as a car passes over; in some wide driveways where the tube must be long, it may give as many as four impulses for the passage of one vehicle if it is traversed at an angle, making these treadles unsatisfactory when used in connection with differential counting equipment. In some types of hose treadle, a metal cover plate reduces the sensitivity to pedestrians. But it may also make the unit insensitive to lightweight foreign cars and more likely to failure under snow and ice accumulation.

The photo-electric cell, actuated by the breaking of a light beam across the driveway, is also used in some installations. This device makes no discrimination between an automobile and any other object breaking the beam. It has the further disadvantage of being easily made inoperative by covering either the light or receiving tube.

Several types of sensing units have come on the market recently, operating on the principle of a mine detector. The sensitivity of these units is adjustable so that they can be set to respond only to an object of the mass and size of an automobile. Since they use electro-magnetic effects, they can be buried under the driveway surface and consequently are not subject to damage or tampering. These devices ideally fulfill the sensing requirements of most automatic parking installations, because they give a steady indication of the presence of an automobile within a certain specific area and are insensitive to the presence of a person or other smaller object.

In certain installations where traffic may pass in either direction, it is necessary to know in which direction a vehicle passes. Directional discrimination can be achieved with almost any type of sensing device by the use of two such units placed in series and connected in such a manner that actuation of "A" and then "B" sends out a pulse on one circuit, and actuation of "B" and then "A" on another. A typical application of directional sensing would be in connection with differential counters recording the accumulation of cars in a parking area served by a single entrance and exit drive. Directional discrimination is also needed in certain gate installations.

AUTOMATIC FEE COMPUTATION

For its operation, this system requires that the ticket issued to the driver upon entering be coded as to the time and date of arrival by punched holes, magnetic ink, or otherwise. When the customer leaves, this ticket is inserted into a computer, which would first compare the time and date of arrival with that of checking out, derive the elapsed time, and then compute from this information the proper fee to be charged, based on the regular schedule of parking fees. The total fee to be collected is displayed to the cashier as well as to the customer, and is also imprinted on the ticket.

This equipment is still in the development stage. When per-

fected and made available at a reasonable cost, it could remove the source of many customer complaints, as well as simplify the cashiering function and provide better control of revenues. A further extension of this mechanism consists of interconnecting the fee computer with a coin box and a gate across the exit drive. Theoretically, this system would eliminate the need for a cashier altogether, even in an hourly type transient facility, since the customer would, after inserting his ticket into the computer, merely have to deposit the indicated parking charge in the coin box, whereupon the gate would open and permit him to drive out. There would remain, however, the problem of the customer who does not have the proper amount of change. Work is currently being done on a change-making machine which will accept paper money, so even this problem may be solved in the near future.

No doubt other devices are being perfected and some, not presently thought of, will be developed as new procedures and problems arise in the parking industry.

Can the Urban Transportation Problem Be Solved?

ROBERT T. HOWE

Mr. Howe is an Associate Professor of Civil Engineering at the University of Cincinnati, where he has been teaching since 1946. He holds the degree of Civil Engineer and a Master's degree in mathematics. In June of 1959, he received a Ph.D. degree after majoring in highway engineering. Mr. Howe teaches courses in surveying, highway engineering, and soil mechanics. A Professional Engineer, registered in Ohio, he is a member of the American Society of Civil Engineers, and several other professional organizations.

WHEN mathematicians are faced with a difficult problem, they often attack it by first finding an answer to the question, "Is it really possible to solve this problem?" If the answer to this subsidiary question is "yes," they can reasonably expect to solve the problem some day. But if the answer is "no," they may only hope, at best, to approach a usable solution. Divergent series, for example, by definition have no sum, and yet the sum of a certain number of terms of such a series may be quite useful.

No one who has really studied the situation has ever proposed a definite solution, so perhaps it is time to inquire, "It is really possible to solve the urban transportation problem?" The writer will attempt to answer this question with a "yes" or "no," so that urban transportation planners may decide whether to continue seeking for a "correct" plan, or to be satisfied with an approximate solution that can be achieved now. Since urban transportation is almost synonomous with movement, and there can be no movement without the expenditure of energy, the answer will be sought by considering various manifestations of energy as they seem to affect the movement of people.

ACTION OF GASES AND MOVEMENT OF PEOPLE

If human beings can be compared to the molecules of a gas, the physics of gases may shed some light upon the phenomena of the movement of people.

The basic law governing the behavior of gases is given by the equation

$$pv = RT$$

wherein: p is the absolute pressure, as in pounds per square foot.
v is the specific volume, as in cubic feet per pound.
T is the absolute temperature, as in degrees Rankine.
and R is the gas constant, a function of the size of the gas molecule such that small molecules have high R values.

This relationship might be translated into human terms

wherein: p is the rate of growth of population of an area.
v is the present population density of the area.
T is a measure of the total energy available to the area.
and R is a "standard of living" index, with a low level of civilization being represented by a large R value.

This translation of terms appears to be valid when the equation is applied to real communities:

1. Evendale, Ohio, became an incorporated village a few years ago and included within its new boundaries a tremendous industrial development just north of Cincinnati. The present population of the village is of the same order of magnitude as it was before the industries developed in the area. The municipal facilities of the village are now among the finest in the metropolitan area while the real estate tax rate is one of the lowest. Considering the above equation, p and v have remained almost constant while T has soared and R has grown much smaller.

2. Many of the cities of China appear to present a contrasting situation. According to recent reports, their populations have been soaring, both in numbers and density, while their industrialization is breaking down together with their standards of living. In terms of the equation, p and v are large and T is small, thus making R very large.

At least one other aspect of the behavior of gases seems to be analogous to the problem of urban transportation. The molecules of a gas in a closed, insulated container are constantly in motion,

even when the container is at rest. The pressure and temperature phenomena of such a gas are explained by assuming that each molecule collides from time to time with its neighbors and with the sides of the container.

If heat energy is supplied to this gas, the molecules will begin to move faster, there will be more collisions, and the pressure and/or temperature in the container will increase. If the container is permitted to expand in volume, a new pressure-temperature-volume equilibrium condition will develop, and will continue until the total energy of the system is again changed. If the volume of the container is not increased, the increased number of collisions will increase the friction between the molecules, and increase the temperature of the system.

Since the concept of "population pressure" is well established, it will not be discussed herein. The energy aspect of the analogy, however, will be discussed briefly. If the average person consumes 2500 calories, in the form of food, each day, he has available approximately 7,500,000 foot-pounds of energy[1] for all purposes. At a guess, probably not more than 500,000 foot-pounds of this energy is available for external work[2]. When primitive man learned to burn wood, he had potentially available a maximum of 5,250,000 foot-pounds of additional energy from each pound of wood[1].

When man learned to extract and burn coal, he had a maximum of 10,000,000 foot-pounds of energy available in each pound of fuel, and when he learned to produce gasoline, less than a century ago, he had as much as 15,000,000 foot-pounds of energy available in each pound of fuel. Of course man and his technology are still unable to harness more than a fraction of these available energies, but the raw figures give some idea of the relative values of food and various fuels as sources of energy.

Since the average worker in the United States today must work at his job for only one hour to provide for himself either the food that he needs for that day, or almost thirty pounds of gasoline, or 200 pounds of coal, he can call to his command truly tremendous amounts of energy. Exposure to so much energy almost forces him

1. Calorimeter values.

2. A 200-pound person climbing to the top of the Empire State Building would use about 200,000 foot-pounds of energy.

to move about more than he would, or could, if food were his only source of energy. This increased movement, of necessity, either causes him to push outward the limits of the city, or to increase the friction within the existing limits.

ENTROPY AND URBAN TRANSPORTATION

Energy tends to migrate from regions of high energy to regions of low energy, and this tendency cannot be reversed without the application of additional energy. A common example of this phenomenon is an electric iron. In order to press a pair of trousers, it is necessary to plug the iron into an electric circuit so that heat energy can be developed from the electrical energy. If the iron is disconnected as soon as it is hot, it will soon be too cool to do effective pressing because the heat energy moves rapidly from the concentrated, high-energy region of the iron to the extensive, low-energy region of the trousers, pressing board, and atmosphere.

The dissipation of energy into unusable forms is called entropy. "The entropy of a system is a measure of its molecular disorder."[2]

Three possible situations must be considered when the concept of entropy is applied to an urban area:

1. When the total energy expended in an urban area is at a certain critical level, the overall condition of the area will be neither improving nor deteriorating. Under such conditions the area is often said to be "static," but it must be noted that nothing in nature is ever static, for at all times some things are being built up while others are degenerating.

2. When energy is supplied to an urban area at a greater rate than it is being dissipated, that area will grow in some way. If this energy is supplied at a constant rate, the area will grow until a new equilibrium between the energy and entropy is established. If this energy is supplied at an increasing rate as the area grows, the growth will continue until the rate of increase of entropy equals the rate of increase of energy.

3. When the rate at which energy is being supplied to an area is smaller than the rate at which energy is being dissipated the area is said to be deteriorating.

As stated above, the analogy between the actions of gases and the movements of people seems to indicate that the people in a city

2. J. F. Lee and F. W. Sears, "Thermodynamics," Addison-Wesley, 1955.

will move about more and more as the total energy supplied to the city is increased. This increased motion automatically increases the number of conflicts, and the resistance to movement—that is, the increase in energy—creates an increase in entropy.

A major task of the transportation planner is to systematize the application of energy to the street system in such a way that the entropy is inhibited as much as possible. Traffic engineers, for example, work and scheme to channelize the flow of vehicles over arterial streets; they install progressively-timed signals; they eliminate turning movements; they create one-way streets.

But these expenditures of energy all too often attract additional traffic to the improved street, and the flow again turns from laminar to turbulent with a resulting increase in entropy. Of course, if no energy is expended on the main streets, congestion will become so bad that motorists will begin looking for alternate routes and the congestion will spread.

If entropy could be eliminated it would be theoretically possible to create a perpetual motion machine.[4] The drift toward randomness in a system can be inhibited only by the expenditure of sufficient energy to maintain order in that system.

TIME, ENERGY, AND AUTOMOBILES

"Conservation of energy" and "the principle of least effort" sound almost synonomous, although theoretically they are not related.

The principle of conservation of energy states that energy can be neither created nor destroyed, but only changed in form. Entropy enters this concept when the energy is changed into unusable form.

The principle of least effort states that nature, in all of its forms, attempts to accomplish its tasks with the least possible expenditure of energy. G. K. Zipf has spent years developing a theory of human behavior and the principle of least effort. His book contains the results of many interesting studies, including some on transportation, which he has conducted to explore this principle.[5]

In human beings, the principle of least effort manifests itself in many ways, varying from outright "loafing" to the constant striving

4. R. L. Sweigert and M. J. Goglia, "Thermodynamics," Ronald, 1955.
5. G. K. Zipf, "Human Behavior and the Principle of Least Effort," Addison-Wesley, 1949.

of the busy executive to carry out his duties in the easiest possible way. There seems to be an important corollary to this principle; for human beings, while attempting to conserve their own personal energies, are frequently prodigious in their use of other forms of energy. This apparent lack of concern for the conservation of the total energy may be illustrated by two common occurrences:

1. A person, wishing to make a small purchase at a store one-half mile from where he is at the moment, is almost always more inclined to take a 3000-pound automobile with him than to use his own energy and walk.

2. One bus carrying fifty passengers certainly requires less total energy than do fifty automobiles each carrying one person. Yet the transit slogan, "It's work to drive. Why drive to work?"[6], seems to have little appeal to those who have a car available to drive to work.

When the highway engineer plans a new facility, he makes a traffic assignment in an effort to determine how many vehicles are likely to use each portion of the road. In essence, he attempts to determine how many drivers will decide that they can conserve their own personal energies by using some part of the new facility.

In addition to attempting to minimize effort for the users of the new road, the highway engineer wants to help them save time. How "time costs" are considered in establishing a benefit-cost ratio, can make a big difference in the apparent feasibility of the project. The adage, "time is money," is certainly no cliché to any organization devoted to the movement of people or goods, nor to any self-employed person who must move from place to place to carry out his work.

But of what real, monetary value is the time that the ordinary person spends in moving from his home to his place of employment, shopping, worship, or recreation? If the average American worker spends one hour each day moving between his home and his place of employment, he can walk about one-and-a-half miles each way, or he can ride a bus from three to six miles each way, or he can drive his own car from five to fifteen miles each way. Traffic delays within the allotted travel time probably have very little monetary value, but they may have great emotional significance.

A person who walks to work may regularly stop to enjoy some scene along the way, and something which causes him unusual delay

6. Slogan on buses of the Cincinnati Transit Company.

may well be of unusual interest, so that he does not mind being detained. A bus rider who reads a newspaper, magazine, or book while riding, will seldom be concerned if the bus is delayed for five or ten minutes enroute.

But the motorist who is delayed by a traffic jam for even two or three minutes may become extremely irritated because he is trapped in a situation he cannot resolve; he cannot leave his car; he cannot move his car, at least not as fast as he would like; he probably cannot even determine what is causing the delay. "Psychological time" is an extremely interesting and important phenomenon, but is there an engineering solution to this problem?

CITY PLANNING AND ELECTROSTATICS

Many city planners believe that personal effort and time can be saved through the development of substantially self-contained communities separated from each other by "green belts." Wilford Owen has stated this concept as follows: "Redevelopment of existing urban communities and plans for new urbanization can help overcome peak-hour congestion by enabling people to live and work in the same areas, either close-in or on the periphery."[7] But is this concept of development realistic?

For the last three years, the writer has been working on an idea for predicting traffic movements on the basis of an electrostatic field.[8] This theory contains the hypotheses that each worker can be represented by a unit negative charge while each place of employment can be represented by a center of positive charge, equal in magnitude to the number of people there employed. Physics tells us that every positive charge in a field tends to attract all of the negative charges within that field. If the field theory of movement is correct, it tends to confute the ideal that self-contained communities would minimize work trips, assuming that such communities are not physically isolated, or insulated, from each other.

As an illustration of the field theory of movement, consider the work-trip pattern within and between the two communities of Lockland, Ohio, which lies on the northern boundary of Cincinnati,

7. Wilford Owen, "The Metropolitan Transportation Problem," The Brookings Institution, 1956.

8. R. T. Howe, "A Field Theory of Land Use and the Movement of People," Purdue University (Ph.D. Thesis), 1959.

and Norwood, Ohio, which is completely surrounded by the eastern half of Cincinnati. These cities are about four-and-a-half-miles apart. Both contain major shopping centers, and neither has schools or hospitals that are likely to attract people from the other. Both are heavily industrialized and of lower-middle-income character. Table I summarizes data on residence and employment in these cities, movement between them as predicted by the theory, and as found by the 1954 origin-destination survey of the area.

TABLE I—WORK TRIPS BETWEEN AND WITHIN LOCKLAND, OHIO AND NORWOOD, OHIO

Characteristic	*Lockland*		*Norwood*
Number of workers living in	2,827		15,691
Number of jobs in	4,148		18,322
Lockland residents who work in	514*		108
Norwood residents who work in	189		3,840*
Passenger car trips found by O & D survey		491	
Personal work trips predicted by theory		594**	
Average number persons per passenger car		1.2	

*As predicted by theory. No check available.
**(108+189) × 2 trips/person.

It will be noted from Table I that, in both cases, the theory predicts that fewer workers are employed in their city of residence than outside of that city, and this despite the fact that in both cases there are substantially more jobs available in the city than workers residing therein. It must be admitted that no direct check was made on the number of residents of each city who work in the same city. Two major checks were made on the predictions, however, and these indicated that the numbers shown in the table are at least of the correct order of magnitude.

PLANNING, IDEALS, AND EXPEDIENCY

Even though the reader may not agree that the data in Table I tend to confute the basic premise of the ideal self-contained community, he will probably agree that ideals and expediency are conflicting principles in the life of almost every human being. We have visions of what we would like to be and have, but all too often we must accept what we can get at the moment.

The writer once commented to several young students of city planning that the average American city seems to have been planned

by the dollar. A prominent traffic engineer, who overheard the observation, asked what better basis there might be for planning. Economic opportunism can scarcely be expected to create the most desirable possible community, but recent accounts of the"planned living" in the U.S.S.R. would seem to indicate that the expediency of the dollar sometimes produces better living conditions than the finest of unfulfilled plans.

It is very easy to recognize the inadequacies of expediency, and perhaps even easier to forget that "our eyes always get bigger." Two years ago the writer had as a house guest a young man from Indonesia, who had been studying highway engineering in this country. After showing this man through some of the worst "slums" of Cincinnati, and explaining to him how the urban renewal plan and the new expressways were going to improve the area, he asked, "Do you mean that they are going to tear down all these good houses?"

This same man is now designing new highway facilities to handle the crowds expected at the Asian Games in Jakarta during 1961. In a recent letter, he wrote that the cloverleaf intersection he is designing will be much more complicated than any that he knows of in the United States because it must have separate lanes for the movement of bicycles.

"Cities in the Motor Age"[9] contains photographs of a congested residential area of Pittsburgh and the Champs Elysées to illustrate the undesirable and the desirable in urban life. Would not corresponding views of a tenement district of Paris and the Cultural Center of Pittsburgh have been equally appropriate?

No one can deny that transportation planning and city planning are closely related and that each depends upon the other for support, but ideals and expediency may frequently conflict in this interdependency. We need better highways today, and we really have no positive way of knowing what our cities will be like even ten years from now. We must plan for the future to the best of our abilities, and then begin to build the highways as soon as possible. We can never hope to achieve the *ideal*.

> "Ah, but a man's reach should exceed his grasp,
> Or what's a heaven for?"[10]

9. Wilfred Owen, "Cities in the Motor Age," Viking, 1959.
10. Robert Browning, "Luria," Act V.

CONCLUSIONS

"Is it really possible to solve this problem?" To a mathematician, a "solution" would be a unique answer which would satisfy the boundary conditions imposed upon the problem. Unfortunately, it may not be possible to define precisely the boundary conditions of the urban transportation problem, because there are so many "feedbacks" in the system.

1. As energy is poured into a city to remedy its existing difficulties, the city becomes a more attractive place in which to live, and the population is likely to increase.

2. As energy is expended to make the transportation system of a city more effective, people find it possible to move farther in a given period of time without a corresponding increase in personal effort.

3. If the above expenditures of energy tend to complicate the problem further, too little effort will permit entropy to increase, and the randomness grows.

4. Unless communities are completely isolated from each other, people will always want to live in one area, and work, shop, study, worship, and play in other areas.

5. So far as the writer knows, no city plan, no matter how well conceived or wisely administered, has ever been able to withstand the assaults of economic opportunism for an indefinite period.

These feedbacks lead the writer to believe that, fundamentally, the urban transportation problem cannot really be solved.

If the problem upon which he is working cannot actually be solved, what then can the urban transportation planner really do? It seems to the writer that he must (1) continue to plan ahead as well and as wisely as his present techniques permit; (2) continue to try to improve his techniques so that his solutions will become better, although they can never be "correct"; (3) accept humbly the plaudits of those who cut the ribbons on the new facilities he has conceived, and (4) realize that, no matter how adequate his solution may appear today, he will probably live to hear people complain about his lack of foresight.

The German General Traffic Plan

PROF. DR.-ING. JOHANNES SCHLUMS

Dr.-Ing. Johannes Schlums is a German engineer for road construction and traffic. From 1930 to 1939, he worked in the administration for road construction in Saxony and in the province of Brandenburg. In 1939, he became professor and director of the Institute for Road Construction and Traffic Engineering of the Berlin Technical University. Since 1949 he has been professor and director of the Institute for Traffic Economy, Road Construction and Town Planning of the Technical University in Hanover. Professor Schlums is a member of the German Academy for Town and Regional Planning, belongs to the Scientific Advisory Board of the German Federal Minister for Traffic, is a member of the Braunschweig Scientific Association, of the advisory board of the Corporation of Public Traffic Management (VÖV), and of the committee for traffic of the German Automobile Club (ADAC).

IN the April 1959 edition of *Traffic Quarterly* are two valuable articles that should be read in connection with each other. Edward J. Logue asks whether towns can survive the age of motor vehicles, and in their article on "Scientific Research in the Field of Traffic Engineering," Martin Wohl and A. S. Lang call for the creation of a "transportation-systems-engineer" profession to cope with many problems in connection with traffic—a desirable cooperation among engineers of several specialized branches.

Growing towns and increasing numbers of cars cause difficulty in Europe also. In the German Federal Republic, the need of close collaboration between town planning engineers and traffic engineers to assure the future viability of towns has been emphasized. A use-zoning plan is recommended in which the development of each town for the next thirty years is projected. That would suggest the way in which various areas of the town probably would be used for different purposes: dwelling, working, recreation. The opening up of new traffic areas is of utmost importance. Therefore, together with the use-zoning plan, a general traffic plan should always be drawn, taking into consideration both private and public local needs.

Within the last few years such general traffic plans have been

drawn for various German towns.[1] Thereby a program for working out such plans, proving useful, was included in the German report presented in last year's International Road Congress in Rio de Janeiro.[2] This program, concerning the development of a general traffic plan for a town, will be discussed in this article. Though the structural conditions in the field of economy and traffic may be different in American and German towns, the methods for solving such problems will supposedly be similar.

a. To begin with, all geographical features of the area in question should be ascertained and laid down in charts, tables, and graphs. Both nature of the area and economic structure determine the extent of the planning area, which in its boundaries normally does not coincide with the political boundaries of the town.

WHAT NEEDS TO BE ASCERTAINED

b. For this area the present population and its location should be ascertained. A good way to illustrate the density of population is to provide spot maps. In co-operation with the town planning office, plans for town expansion, the expected population and its location within a planning period of thirty years should be determined. At the same time, the future density of population and the resultant heights of buildings should be stated. With respect to the purpose of any building—dwelling house, office building, plant, store—the extent to which it will produce traffic by itself should be estimated. This careful, premeditated planning is necessary in other fields of engineering; for example, in the case of supplying water and electricity, and in questions concerning disposal of waste water.

c. With regard to actual conditions, censuses of the local public and private traffic should be taken. For local public traffic, the following details have to be ascertained:

1. A system of overhead railways, trams, trolleybuses, and

1. J. Schlums: *General Traffic Plan for Osnabrück*. Walter Dorn: Bremen-Horn, 1956.

2. J. Schlums: "The basis of the general traffic plan." *IXth International Road Congress Rio de Janeiro 1959*, Section II, Fifth Question, Report of the Federal Republic of Germany.

Cf. M.-E. Feuchtinger und J. Schlums: "A traffic study concerning the arterial road system in the Munich area." Report presented at the Second International Course in Traffic Engineering, 1954. The World Touring and Automobile Organisation (O.T.A.), 32 Chesham Place, London S.W. 1.

omnibuses. At the same time the degree of rail maintenance and of conducting wires should be ascertained for all sections.

2. Timetables provide information on the number of vehicles put into circulation and consequently on the charge of the sections.

3. Traffic flows should be ascertained by passenger counts. At the same time, the rate of changing among the different lines of the same means of communication, as well as from one conveyance to another, should be determined. Through these censuses, one obtains the curve of distribution for the lengths of journeys, which must be known. It may be expedient, in the case of a traffic census, to restrict them to representative counts that are mathematically founded.[3]

A DISTINCTION MADE

The private traffic volume should be carefully ascertained for present construction works. A distinction should be made between moving, on-and-off loading, and parking traffic. Through origin-and-destination studies, the changes corresponding to the originating and terminating traffic of the town or of parts of it can be ascertained.[4] It may prove expedient to determine the parking traffic by air views. By the zoning plan, it may be possible to estimate anticipated flows of traffic and future parking requirements. In the zoning plan, the road system has to be arranged to meet future traffic volume. It may prove necessary to put into use further levels (tunneled sections, overhead street).[5] One must try to satisfy future parking requirements in the zoning plan by spaces at ground level, by multistory and underground garages.

d. The alternating relationships between local public traffic and private traffic: In this analysis special attention must be paid to those areas where changes from one means of communication to another are expected to take place. Accesses to the subways have to be constructed in an expedient way and their width has to be calculated correctly.

3. F. Pampel: "Method and Results of a Census of Travel Lengths and Traffic Flow." In *Verkehr und Technik*, 1955, No. 7, p. 187.

4. J. Schlums: "Air Views as a means of Traffic Engineering." In *Strabe und Autobahn*, 1956, No. 5, p. 149.

5. J. Schlums: "Urban express roads." Report of the International Concrete Road Congress, Rome, 16–19 October 1957.

e. Examination on accidents occurring in the area may suggest proposals for measures to improve the road system. In particular, spot maps and collision diagrams are helpful. Valuable information and basic data for improvement measures may be obtained by correlative research on the relationship between number and gravity of the accidents on the one hand and between the density of population, distribution of vehicles, and width of roads on the other hand.

f. In providing a general traffic plan it should be determined as to which measures will be advantageous for the town as a whole or for different areas:

1. It must be determined whether possible to keep the city free from private traffic. This matter may come into question in the case of small towns, with small centers. Under such circumstances sufficient parking lots must be available near yet outside the center; walking-distance should be kept to a minimum.

2. Whether one-way streets are of advantage: If streets are of sufficient width, both sides of a one-way street may be used for parking. Above all, traffic at intersections is alleviated with one-way streets. A disadvantage of a one-way street system may be that greater distances must be covered to reach a destination.

3. Whether it is possible and expedient to prohibit totally or for certain periods the passage of trucks. In such a case, restaurants, stores, and covered markets should be provided beyond the peak hours.

4. In drawing up the zoning and general traffic plans, an effort should be made to develop separate systems for the different kinds of traffic (pedestrian, cycle lanes, streets for motor vehicles, special lanes for trams). They should be as independent of one another as possible. The road system and the kind and density of the population should be well co-ordinated. The town and the road system should be formed in such a way that as little traffic as possible is caused and that with a minimum of expenditure a maximum of opening up of traffic areas is obtained.[6]

5. With regard to growing traffic, it should be determined whether second or even further levels should be used. In this case it must be considered whether private or public traffic should be transferred to a different level. In the zoning plan, buildings in the

6. P. Friedrich: *The Calculus of Variations as a means of Town and Regional Planning.* Walter Dorn: Bremen-Horn, 1956.

expansion areas of the town should, from the beginning, be arranged so that in case of growing traffic and inclusion of different levels, ramps for tunneled sections and overhead streets can be built and so that on both sides of these ramps, sufficient width can be left available for the ground-level streets, among them the frontage streets. In this way removal of buildings can be avoided.

6. In German towns it is especially the different kinds of vehicles of divers sizes and driving characteristics that cause difficulties. Bicycles, motor-bicycles, motorcycles, cars, trucks, buses, and trams bring about a heterogeneous traffic. In individual cases, it should be determined whether traffic can be made more homogeneous by abolishing trams and introducing trolleybuses or omnibuses. The latter can be more easily adapted to the flow of traffic. Furthermore, omnibuses can be put into service anywhere, to ascertain empirically the traffic requirements of individual areas.

Satellite towns can be attached to the city by bus lines. On the other hand, trams have the advantage of carrying more than one car, thus offering greater service if warranted. If a system consists of narrow roads, the mastering of traffic at intersections and squares can be determined for the kind of vehicle used in the local public transportation. At these points, it is advantageous, especially for the turning-off traffic, that buses form part of the flow of private traffic.

MISTAKES IN ZONING PLAN

g. In drawing up a general traffic plan it may prove expedient to examine the intersections for free-flowing traffic on signal. Measures should be taken to provide signalization.

Often a mistake is made by failing to indicate in the zoning plan, and in the general traffic plan, the streets as lines or ties without ascertaining the correct widths of the streets. The required capacity of the streets and adequate intersections for the traffic volume expected in the future should be considered.

If a zoning plan does not provide sufficient space for intersections, then it often proves impossible to make them efficient later on. One or a few intersections not corresponding to the traffic requirements can reduce to zero the traffic value of considerable sections of a road system. Thus it is possible that because of defective opening up of new traffic areas, entire regions are reduced in their value and accessibility.

h. Local public transport systems must not only be examined with regard to their system and their management. It is necessary to provide an analysis of factors of economy. Initial installation costs should be compared with tariffs. Where trams are abolished in favor of trolleybuses or omnibuses, the age of the installations and of the vehicles has to be ascertained. Eventual depreciation-remainder must be added to the cost of new vehicles.

i. Where the type of public vehicle is changed, the network and the alignment must also be examined. At the turn of the century, often only a few lines of trams were established in German towns. With the growth of the towns, individual lines were installed according to the requirements. This resulted generally in an uneconomic form of network.

j. A general traffic plan should indicate an expedient sequence of improvements proposed, to avoid any delays and keep to a minimum the expenses for unforeseen measures. Naturally, each step forward in the process of completion should produce a relative optimum in traffic improvements.

k. The general traffic plan should not be utopian. Improvements proposed should correspond to the economic strength of the town. Only then can it be guaranteed that, according to growing traffic requirements, the general traffic plan will be totally realized within a reasonable period of time.

l. In town planning, it should be noted that towns do not expand to their greatest advantage without fixed plans. The intention should be to create separate areas or neighborhoods with separate administrations, schools, and public-supply undertakings, so that a certain independence is provided. The amount of traffic between these neighborhoods and the city should be previously calculated. The necessary connections by roads and public transport conveyances should be outlined or designed.

m. As mentioned before, the use zoning plan and the general traffic plan should be drawn up for a planning period of thirty years. About every five years, a reviewal should be made. It might become necessary to change the zoning plan and the general traffic plan. In such a case, in view of the dual relationship, it should always be determined as to how far such partial deviations indicate revisions in the overall planning. A specific method in drawing up a zoning

plan and a general traffic plan should in every case be implied, if new towns or new self-contained areas are to be built. It is more difficult to adapt towns that date from the times of carriage traffic to the requirements of changing development.

VIABILITY OF TOWNS

The only possible way of assuring, under conditions of growing traffic, the viability of towns, is to provide general traffic plans and thereafter to review them constantly in view of town growth. Town planners and traffic engineers should keep in close touch; such co-operation will be rewarding. Between the local public traffic and the private traffic, a balance should be found that will best correspond to the traffic requirements and to the size and kind of areas available. It becomes a difficult undertaking for which M. Wohl and A. S. Lang want to introduce in America the profession of a transportation-systems-engineer.

In Germany, the education of engineers has not been so specialized as in America. We, too, are of the opinion that it is for the good of our towns if all different types of traffic are seen and handled in connection with each other, and if the zoning plan and the general traffic plan are developed simultaneously.

Taxicab Operation in London

JOHN HOUGHTON

Mr. Houghton was appointed in 1957, at 36 years of age, Managing Director of the largest Taxicab Operating Company in London, England. Before 1957, he was Export Sales Manager of Ford Motor Company Limited, England, and knows the United States well. He is a Fellow of the Incorporated Sales Managers' Association of England, and his company also has interests in the automobile, trucking and parking facility fields.

A SURVEY of taxicab operation and public transport in London, England, in relation to American standards, is apt to be confusing. Some review must therefore be made of the historic, social, and political factors that lead up to our present situation.

When the main network of road communications covering the country was first being laid down, London was a small trading post that rated no greater importance than many other small trading posts scattered across the island. The principal lines of communication, started from the southeast corner of England, ignored the small settlement that is now the heart of the City of London, and the main river crossing was at a point farther west, approximately where now stand Westminster Bridge and the Houses of Parliament.

The primitive road network was further developed and better aligned during the Roman occupation, and until recently a combination of the pre-historic and Roman road systems was the basis for our modern road network. It was not until comparatively early in the city's history that the road network recognised London's existence. The construction of London Bridge—the first to be built across the Thames, at a point slightly east of the present London Bridge—twisted the alignment of roads to cross the river here.

Here then was a pattern of main highways leading from the ports of access from continental Europe, and spreading out across the whole country, by-passing a small trading settlement on the west, but with short connecting links from these main highways to that small settlement.

The later Saxon invasions, the decay of power of the Roman

Central Government, and failure of successful legislatures up to the middle of the 18th century, left our road system in a chaotic state of neglect. In fact, the trade of the City of London was developed largely upon the river Thames, which has been described as a shining roadway leading to all parts of the world. The City of London grew and prospered on its water-borne trade and became the administrative centre of the country.

As it grew it overlapped and absorbed into itself the highways that had previously by-passed it, and these formed the communication network of the country. This spread of growth over what were originally through-routes has created one of the largest problems of traffic movement in the City of London of today. Highways still carry the through-traffic for which they were intended; but they carry also the urban traffic of one of the greatest commercial cities in the world.

SOCIAL, POLITICAL AND TRADITIONAL FACTORS

The vast growth of London has taken place in the last two hundred years, and coincides in time with the industrial revolution. This industrial revolution was characterised by many sacrifices of the standards of human values in the pursuit of "progress." Taste was secondary to speed; human values were secondary to profit; and the abilities of the legislature were inadequate to produce any comprehensive over-all plan that could have avoided some of the difficult factors to which we are now almost irrevocably committed.

Traditionally-minded by nature, Londoners based their personal transportation pattern—which grew up in the period of most vigorous expansion—on a rigidly defined social system which can be (perhaps over-simply) stated as "those with the money had carriages, and those who didn't had to walk." The spread of the City brought with it problems of travel that could not be solved by existing means.

Nevertheless at this time the railway network was growing in line with the expansion, and was the first true method of public transport freely available to the rapidly growing working-class population. At this stage then, upon an already antiquated highway system, was imposed a comprehensive and very efficient network of railway services.

During the reigns of Queen Victoria and King Edward the Seventh, this growth-process continued at a high rate, and with it came intensified subdivisions of social level. At this time a strong middle-class element emerged. Technical improvements in surfacing methods for highways and urban road systems raced ahead of any development of the systems themselves, and surfacing improvement led to a greater adoption of road transport.

Improvements of design led to the construction of much lighter and cheaper vehicles, thereby bringing road-transport vehicles within the means of a greater number of people. There have always been vehicles for hire in London, certainly as far back as the middle of the 17th century, but it now became quite socially acceptable to hire a carriage, rather than to maintain one's own carriage at great expense. This practice gave a very considerable impetus to the hackney-carriage trade and at the beginning of the present century this trade was flourishing at what was probably the peak of its prosperity.

The arrival of the motor vehicle and transition from the horse-drawn were smoothly accomplished, and take us up to the present situation whereby the increase of material wealth and continued expansion of the middle class have lead to the following factors:

1. Privately-owned motor vehicle transport is at a level greater than it has ever been.

2. A railway network, extremely comprehensive in its coverage and in its peak working facilities, has encouraged the further extended spread of Greater London.

3. Rapid and effective public omnibus facilities make transit from rail terminals to commercial and industrial locations simple and effective at very moderate cost.

4. All three patterns are superimposed upon a vast city whose road network is still based upon the needs of the country during the period of the Roman occupation.

WIDE CHOICE OF TRAVEL METHODS

The visitor or commuter arriving in London (other than by his own private transport) has a wide choice of travel method to his destination—bus, underground rail, taxicab, or on foot. His arrival method may be by main-line rail, by "underground" railway from

outside London via overground section, by long distance coach, or by limited access feeder bus service.

At each of the major stopping points, be they terminals or interconnections, adequate and comprehensive facilities exist for interchange, and in the case of rail interchanges, these facilities are nearly always under cover. Bus-interchange facilities, although not so adequately catered for under cover, are frequently at identical locations since the feeder service and the urban service have common stopping points.

Coach, and bus-to-rail interchange facilities are much less adequate and conveniently disposed. In serving this interchange problem, the taxicab begins to function in those instances where speed is important, where comfort requirements over-ride the convenience of public service facilities, where goods or baggage have to be moved, where visitors are unfamiliar with the city or its public service facilities.

Taxicabs may also be used in the relatively rare cases where public interchange facilities fall below the normal standard, or where urban rail or omnibus services are not "angled" correctly for easy transit. (This can occur, for example, where river crossings, or the Royal Park complex of Hyde Park, Green Park and St. James's Park intervene between two points).

The commuter making use of his own private transport presents a separate traffic problem. Accustomed to the freedom from need to use the public transit services, or perhaps revelling in the possession of personal transport for the first time, our urban commuters show the same characteristics as in your country—principally the desire for parking facilities as near as possible to their destination.

The law relating to use of the highway is one which originates deep in history and in theory the only action that can legally be performed on the public highway is that of movement between point of origin and destination. Thus, strictly speaking, parking is not permitted on any highway. Nevertheless, with the significantly increased use of private transport since the end of the last war, congestion caused by parked vehicles has made it necessary to introduce permissive legislation to define parking activity; and in the last two years the appearance of metered parking zones derives most of its know-how from established American practice.

This problem has by no means been solved, nor is there yet any significant development in the provision of off-street parking facilities. This fact has lead to a situation where the possession of private transport defeats its own ends; lack of parking space, congested streets, and the absence of adequate through-routes are producing a traffic situation which, in the words of an American traffic engineer, would have led long ago to complete traffic stagnation, were it not for the patience and good sense of the average London driver.

For example, the commuter now finds that, in a daily journey of ten miles, the last two miles may take twice as long to cover as the first eight miles, and already the private user is finding it more convenient to park outside the congested zone and continue from there to his destination by public transport. Nevertheless there is revulsion against this retrograde step—having bought a car in order to be free of public transport and then having to use public transport anyway—and two separate trends are emerging. The first is for increased use of taxicabs; the second, to leave the car at home during week days and travel normally by public transport.

Naturally there are activities that involve the use of a taxicab or some other professionally driven private vehicle, that cannot be served by public transport. These include occasions in which speed and convenience are paramount, where a particular standard has to be maintained (in what might be called "expense account" living), where gallantry or chivalry are required (particularly evening theatre and dinner entertainment), for sight-seeing (although this is also covered by conducted coach tours) and for travel to and from specialised destinations.

TAXICABS AND THE LICENSING AUTHORITY

London can rightly claim the best taxicab service of any capital city in the world, partly because of a tradition of service, and partly because of the firm control maintained by the Licensing Authority, a police department of Scotland Yard known as the Public Carriage Office (P.C.O.). This body concerns itself with the licensing and operation of taxicabs, and the examination and licensing of drivers.

Much of the legislation affecting the cab trade dates back to the middle of the last century. There are inevitably many inconsistencies in the law, and in some cases penalties that can be imposed have

little value as sanctions in terms of modern costs. It is general opinion that the Public Carriage Office maintains a fairly balanced interpretation between a reasonable requirement on their part and a strict interpretation of the law. Persistent attempts to evade the law, apart from the penalties which the law can bring to bear, can lead to a perfectly legitimate tightening by the Public Carriage Office of their interpretation of the letter of the law so far as it applies to the delinquent operator.

VEHICLE DESIGN

Construction and Use Regulations lay down physical requirements to which any vehicle put in operation as a licenced taxicab must conform. Conformity is judged by the Public Carriage Office, to whom the prototype vehicle has to be submitted prior to receiving "type approval."

These regulations effectively require a specialised vehicle, and standard passenger cars will not qualify unless very extensively modified. Thus the market for specialised vehicles as required by the London regulations has hitherto been confined to London. Recently, however, the sheer good sense of the regulations and the functional nature of the vehicle's design are having considerable impact not only in provincial centres of the United Kingdom, but in other countries of the world.

This limited market—coupled with the high cost of tooling amortisation, and a tendency to extend the operating life of a cab as long as possible—accounts for the high initial cost of a cab (£1,200) and also for the somewhat out-of-date appearance of the London taxicab fleet. In recent years considerable change has taken place because of the P.C.O.'s relaxation of certain design requirements, and the introduction of a new vehicle based on these design relaxations. The tendency on the part of at least the major operators to maintain a three-year cab life, has done much to correct this out-dated appearance.

The latest type of cab to enter service in London is equipped with a four cylinder 65 b.h.p. diesel engine and Borg-Warner automatic transmission. It also, for the first time in cab history, has a front door on the side opposite the driver to enclose the luggage compartment.

Visitors will have noticed that the majority of London's taxi-

cabs are finished in black. This custom springs mainly from the insistence of the suppliers in providing them in black only. It is also difficult to justify the additional cost of a livery in terms of any additional revenue. Our laws provide that taxicabs shall carry no advertising material on the outside. This regulation has inhibited the tendency to advertise individual cab companies and it is a matter of some difficulty to decide the border line between identification and advertisement.

MAINTENANCE REQUIREMENTS

A cab operation licence is valid for twelve months only. On first putting the vehicle into service it has to be taken to a Public Carriage Office "Passing Station" where it is scrutinised to confirm that it passes the fitness regulations. It is then granted its operating permit, and at the end of twelve months' operation it must be re-submitted for an extension of the approval. This obviously involves a very extensive and costly overhaul, since the vehicle must be re-presented in a condition substantially similar to that when it was first approved.

Periodic inspections are carried out by officers of the Public Carriage Office at the base garage of each operator. Inspection is done (approximately) quarterly, but can be stepped up to a greater frequency at the discretion of the Public Carriage Office, particularly in the case of any delinquent operator.

STOP NOTICES

The inspecting officer can prohibit any vehicle from operating by issuing a "Stop" notice; either a "Two Day Stop" (in which case the vehicle must be rectified and can then operate after the second day has expired) or by a "Full Stop," in which case the vehicle has to be re-submitted to the Passing Station before it may be operated again.

Stop notices may also be issued at any time against any cab while operating in service. This is a quite frequent practice, especially at main railway terminals where a high volume of taxi traffic is concentrated.

Apart from its obvious desirability in a business serving the public, cleanliness is also very closely watched by the Public Carriage Office, particularly by the officers working at railway termin-

als. It is general practice in the trade to wash and clean each operating cab thoroughly each day, including the vacuum cleaning of all seats to remove traces of cigarette ash in any of the seam lines of the upholstery.

In our own operation, we have a wash rack similar to those used in auto laundries in the North American continent but this rack has been specially automated since it operates on a standard vehicle. The majority of other operators still use bucket, hose and wash leather.

APPROVED METERS REQUIRED

Meters are mandatory, and much legislation is devoted to ensuring that no evasions of the fixed meter tariff can take place. The main legal provision states that, "A cab driver must set the taximeter mechanism in motion as soon as the cab is hired and no sooner, and stop it as soon as the hiring is terminated and no sooner."

All police officers, whether from the Public Carriage Office or not, are very zealous in seeing that this regulation is maintained. Meters must secure Public Carriage Office approval for type and operation, and are tested for accuracy by the National Physical Laboratory, whereupon they are sealed. When a meter is installed on a cab the installation itself is sealed and cannot be changed without breaking this seal.

Since any mechanical failure can only be rectified by fitting an exchange unit, the seal has to be broken and the vehicle must then be re-submitted to the Passing Station for re-sealing. It follows that the operator must be certain, on its arrival at the Passing Station, that the cab is in a condition to avoid being given a "Stop" notice for any defect. In our experience a meter failure can prove very costly in terms of minor vehicle reconditioning, loss of revenue, and administrative cost, quite apart from the cost of the meter charge itself.

Many companies, our own included, rent their meters from manufacturers and it is for this reason that reliability and absence of failure in the meter are of greater importance to us than the rental cost. The rental system used in London also means that fullest advantage can thus be taken of any of the improvements in design.

Cab ranks are marked and licensed by the metropolitan police. Demand and location are carefully surveyed to determine size and extent of use. They are open to all cab drivers and thus no cab proprietor has or can have any monoploy of ranks. Similarly, there can be no concessions let by hotels, railway terminals, etc.

RANKING AND RADIO OPERATION

Telephones are installed at a number of the busiest ranks as a public service and all rank numbers are listed in the telephone directory. This service is provided by the General Post Office.

No proprietor has any direct tie-line to any rank. The leading cab on the rank takes incoming calls, and is obliged by law to do so. The meter is set in operation on leaving the rank.

The major rail and airport terminals are again closely controlled by police, and the principle of "first come first served" is applied both to cabs and to those who wish to hire.

Two-way radio telephone operation was introduced after the 1939–45 war but, at the moment of writing, the major London network, itself as big as the other three networks put together, has announced that it will cease to operate in the immediate future. It is therefore difficult to comment on London radio taxi operation at least until the dust has died down from this particular decision.

As in most cities, cabs can be hailed when passing on the street. In this case the driver is not obliged to stop, but if he does then he *must* accept the fare in question. For a journey of more than six miles or one hour in duration the driver may negotiate a special price for the journey, which must be agreed at the outset of the hiring.

CAB-DRIVER EXAMINATION

The licensing of cab drivers is one of the most unusual features of the London taxicab trade.

Because of the city's size, its haphazard development over many hundreds of years, and the irregularities of its layout, an intimate knowledge of streets, public buildings and most direct routes is required by all drivers. Any cab rider is entitled by law, on hiring a cab, to be taken to his required destination by the most direct route, and to do this the driver must be certain both of his actual destination and of the most direct route to it. In a city with many

one-way streets, this certainly can even involve knowing how the premises' numbers run.

All drivers, before being licensed must therefore have an encyclopaedic knowledge of London, which is gained by many months of painstaking study on foot and by bicycle. They must be able to describe the shortest route from any point to any other point by naming the streets and the manoeuvres required at each turning or block intersection. This would not be difficult on a rectangular block plan, but in London it is a highly complicated process.

In practice the examination is carried out on a number of known routes, but frequently a "snap" route is asked for to determine whether the trainee driver has physically studied the street system or merely learnt the answers from study books.

The "Knowledge of London" examination, conducted by the metropolitan police, can take a year to pass, and the fastest pass on record took five months.

In addition, examination is made of the individual's driving ability and moral character. Thus the London cab driver is a true professional driver who has set out to make his career in the business and there can be no question of casual labour in the trade, or of hiring and firing to suit seasonal demand.

URBAN TRANSIT, SPEEDS AND COSTS COMPARED

No comparison between taxicabs and public service vehicles can be very meaningful, since so many factors differ.

However, the following table may be used to compare taxicabs, bus services and the subway (underground rail), for times taken for journeys (assuming that the vehicle is instantly available at the precise starting point and discharges at the precise destination). In the case of subways, times are taken from subway level.

It is obvious that the taxicab does not compete with public transit systems, either in cost, or, in the case of the subway, in speed. The taxicab service does, however, offer the following, in addition to the convenience factors mentioned previously.

1. Fares are based on the shortest distance between origin and destination.

2. Speed (relative to normal traffic conditions) is good, and because of the directness of the route—unless the route coincides with a subway route—is as fast as any available. Where the route

coincides with a subway route, the time lost in reaching subway level and regaining street level (say three minutes each end) means that for journeys up to three miles, a taxicab is faster than the subway but beyond three miles the higher average travelling speed of the subway puts it ahead.

LONDON CENTRAL AREA

		(Fares in pence) BUS		(Time in minutes) SUBWAY		CAB*	
		Time	*Fare*	*Time*	*Fare*	*Time*	*Fare*
1 mile	1 person	8	2	3	2	5	27
	2 persons	8	4	3	4	5	33
	3 "	8	6	3	6	5	39
	4 "	8	8	3	8	5	42
2 miles	1 person	16	4	6	4	10	42
	2 persons	16	6	6	6	10	48
	3 "	16	8	6	8	10	54
	4 "	16	10	6	10	10	60
3 miles	1 person	24	6	9	6	15	57
	2 persons	24	12	9	12	15	63
	3 "	24	18	9	18	15	69
	4 "	24	24	9	24	15	75

*Does not include tip.

In order to demonstrate the high utilisation achieved by the London taxicab fleet, the following figures are quoted from the 1958 Census of Traffic for the four most intensively used traffic intersections in London over a twelve-hour period from 8 a.m. to 8 p.m.

Intersection	*Automobiles*	*Cabs*	*Buses*
Hyde Park Corner	41,682	19,945	6,328
Trafalgar Square	28,819	16,517	6,418
Parliament Square	29,576	8,938	4,588
Marble Arch	31,343	10,741	5,536

Since the total cab fleet in operational use is about 5,600, this intensity of public taxicab usage shows that the attractions offered by the taxicab service are well recognised, despite the apparent convenience of the public transit system. Of all traffic movements throughout the whole metropolitan area of London, taxicabs amount to 7.31 percent, buses to 5.9 percent, while automobiles have the majority share at 42.72 percent.

Highway Bridge and Tunnel Toll Rate Schedules

LAWRENCE S. WATERBURY

Mr. Waterbury is a Consulting Engineer of wide and diversified experience in the field of transportation. His career spans four decades of America's greatest growth. His engineering reports have led to the construction of more than $2,000,000,000 worth of tunnels, bridges, causeways, highways and other toll projects stretching two thousand miles across the nation. Mr. Waterbury was a senior partner of Parsons, Brinckerhoff, Hall and Macdonald, one of the nation's oldest and largest engineering firms. After a twenty-year tenure, he retired from the organization in 1956 to set up his own firm in New York City as engineering consultant to government, industry, and other consulting engineering firms. He is a member of the American Society of Civil Engineers, Institute of Traffic Engineers, Highway Research Board and other technical organizations and is a licensed Professional Engineer in several states.

A STUDY of the development of highway transportation in Colonial America and the United States during the last four centuries impresses one with the enormous problem created by the necessity of crossing innumerable rivers. In the early days, many of the rivers were used extensively for travel from one area to another and this use continues to a considerable extent today. Canals developed in a number of regions connected and supplemented the system of transportation provided by the rivers. Some of these are still in use.

The requirement of maintaining navigation on the rivers and canals has been a factor that generally increased the cost of constructing bridges and tunnels across the waterways. Until the advent of the automobile and the increase in highway traffic the demand for bridge crossings of the rivers was not too serious a matter. Ferries were generally adequate to carry traffic across the rivers.

During the period from 1920 to 1940, a tremendous growth in the use of motor vehicles for passenger and commercial transportation resulted in greatly increased traffic volumes and necessitated an expansion in highway construction. However, the expenditure needed for constructing modern bridges and tunnels, greater than

for equal stretches of highway, has meant that the building of these facilities has not kept pace with highway construction, and free movement of traffic has been seriously hampered.

With increased highway mileage and accompanying increased traffic, the demand for more and more bridges and tunnels has multiplied and, notwithstanding higher construction costs, they are now more than justified for satisfying traffic needs. However, the problem of how to finance these facilities still remains serious.

Cities and states were able during the twenties to finance these needed facilities from their tax revenue and general credit, and users were not required to pay a toll. However, in many instances the demand for financing other types of state and municipal needs made it difficult to secure funds for bridge and tunnel construction. At some locations, where the need for a vehicular crossing was so great it appeared that a profitable venture might result from operating the project as a toll facility, private companies were organized to build and operate the bridge or tunnel. Some of these companies are still in operation today in various sections of the country, but most of these started in business prior to 1930.

FINANCING BY REVENUE BONDS

Neither of these methods was successful in fulfilling basic traffic needs. As a result, another method of financing was developed through the issuance of revenue bonds by public agencies or political subdivisions. The interest and principal of these bonds are payable exclusively from net earnings of the projects.

In 1926, the Port of New York Authority sold revenue bonds to finance several bridge projects, and these bonds were payable from the operation of various projects under jurisdiction of this agency. In 1928, public toll revenue bonds were issued for financing the construction of a bridge over the Ohio River at Louisville, Kentucky. Since that time, many millions of dollars in revenue bonds have been sold by public agencies to finance construction of more than a hundred bridges and a few tunnels. In addition, a few billion dollars of revenue bonds have been sold to finance construction of many miles of toll roads.

While a slow-down in the financing of toll-road, bridge, and tunnel projects has occurred since the Federal Interstate Highway

program started in 1956, it is quite possible that toll roads, bridges and tunnels may be needed to augment the federal highway program if we are to keep abreast of future defense and industrial traffic requirements and complete the project somewhere near its present schedule.

The giant government road development program, now nearing the close of its third year in operation, was originally supposed to be completed in thirteen years. Its administrators have conceded that the program presently authorized probably will take fifteen to sixteen years, and cost an additional sum of $13.4 billion.

In reviewing the road program's progress during the last year, and looking toward the coming twelve months, it appears that the delay was not due to those in charge—talented and dedicated men who face an extremely complicated task. Uncertainty as to the availability of adequate funds was an important factor.

Toll-road, bridge and tunnel development should be encouraged as a necessary adjunct to the system free of tolls, and those states that can now undertake such programs should receive credits as an incentive.

Because of increasing truck and passenger car travel, it is doubtful if the government project can keep abreast of requirements unless financing by tax revenues is supplemented by financing part of the program through revenue from tolls. Locations that might be adaptable to toll-financing are a number of bridges or tunnels across the various rivers and vitally-needed expressways in many of the larger urban areas. It is particularly in urban areas that the program at present is most seriously behind schedule.

ESTABLISHING TOLL RATE SCHEDULES

A schedule of toll rates for highway bridges and tunnels involves the establishment of fair and equitable rates for each class of vehicle. The rates must produce sufficient revenue to provide for operation and maintenance costs of the project and for interest on and retirement of the debt incurred in financing it.

In a typical trust indenture securing a bond issue to provide funds for construction of a highway bridge or tunnel, a commission or authority or other public agency covenants "that it will establish tolls for traffic using the bridge or tunnel that will be sufficient:

a. to provide funds for current expenses of operating and maintaining the bridge;

b. to provide funds for a replacement reserve fund; and

c. to provide funds for payment of interest on the bonds and principal in such years as set forth in provisions of the indenture."

In the case of interstate bridges that have been authorized under the General Bridge Act, Public Law 601, 79th Congress (Chapter 753—2nd Session) (S. 2177), and as amended by Public Law 550, 80th Congress (Chapter 336—2nd Session) (S. 1651), it is pertinent to quote provisions of this amended Act:

"AN ACT to amend the General Bridge Act of 1946.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the General Bridge Act of 1946 be, and the same is hereby, amended by striking out section 506 thereof and by inserting in lieu of said section a new section to be designated as section 506 and to read as follows:

"SEC. 506. If tolls are charged for the use of an interstate bridge constructed or taken over or acquired by a state or states or by any municipality or other political subdivision or public agency thereof, under the provisions of this title, the rates of toll shall be so adjusted as to provide a fund sufficient to pay for the reasonable cost of maintaining, repairing, and operating the bridge and its approaches under economical management, and to provide a sinking fund sufficient to amortize the amount paid therefor, including reasonable interest and financing cost, as soon as possible under reasonable charges, but within a period of not to exceed thirty years from the date of completing or acquiring the same. After a sinking fund sufficient for such amortization shall have been so provided, such bridge shall thereafter be maintained and operated free of tolls. An accurate record of the amount paid for acquiring the bridge and its approaches, the actual expenditures for maintaining, repairing, and operating the same, and of the daily tolls collected, shall be kept and shall be available for the information of all persons interested.

"Approved May 25, 1948."

There is another piece of legislation relating to the construction of bridges by the states whereby they can receive federal aid. To date this legislation has not been used very extensively, even though no time limit is set for repayment of the debt incurred for the construction, but the bridge must be operated free of tolls when such debt is repaid. The legislation referred to is the following:

Public Law No. 773, 69th CONGRESS (H. R. 16551)

"An Act to permit the granting of federal aid in respect of certain roads and bridges.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that notwithstanding any provision of the Act entitled 'An Act to provide that the United States shall aid the states in the construction of rural post roads, and for other purposes,' approved July 11th, 1916, or of the Federal Highway Act, the Secretary of Agriculture may extend, on the same basis and in the same manner as in the construction of any free bridge, federal aid under such Acts, in the construction of any toll bridge and approaches thereto, by any state or states, or political subdivision or subdivisions thereof, upon the condition that such bridge is owned and operated by such state or states, or political subdivision or subdivisions thereof, and that all tolls received from the operation thereof, less the actual cost of operation and maintenance, are applied to the repayment to the state or states, or political subdivision or subdivisions thereof, of its or their part of the cost of construction of such bridge, and upon the further condition that when the amount contributed by such state or states, or political subdivision or subdivisions thereof, in the construction of such bridge shall have been repaid from the tolls, the collection of tolls for the use of such bridge shall thereafter cease, and the same shall be maintained and operated as a free bridge.

"Approved, March 3, 1927."

The foregoing references to the terms of a trust indenture and to certain legislation regarding the financing and operation of toll bridges and tunnels point out the very definite requirements for an adequate system of toll rates. Development of such toll rates requires a full analysis of the various factors affecting traffic expected to use the bridge.

TRAFFIC STUDIES AFFECTING TOLL RATES

The first step, after a preliminary analysis indicates that the project is financially feasible, is to make a full-scale origin and destination traffic survey. This survey should be comprehensive enough to fully reflect the movements of traffic during an average day, or over a period of one year. In addition to origin and destination data, the survey should show the various types of vehicles using present highways and, in the case of commercial vehicles, the types of commodities carried.

Concurrently with this origin and destination traffic survey, it is essential that certain additional studies be carried on. These include:

1. A study of past records of traffic in the area, and of the traffic, its composition, and earnings of competing facilities in the project area;

2. A time and delay study over present routes, and a comparison with proposed future routes as to time or distance savings, for the various classes of vehicles moving in the area;

3. A tabulation of population, motor vehicle registration, and gasoline consumption in a wide-spread area during the last ten years and, in addition, a projection of their estimated future growth;

4. A statement and analysis of advantages of the new route over presently available facilities;

5. An estimate of possible induced traffic that might be attracted to the new facility, over and above the normal anticipated growth;

6. A land-use study of the project area in the past, and of possible or probable changes in the future;

7. In addition to the land-use study, a study of past, present, and future projected general economic conditions in the area to be served by the new facility;

8. A compilation of toll rates charged for each class of vehicle on any competing facilities to be replaced or supplemented by the new project.

Upon completion of the origin-destination survey and concurrent studies, an estimate should be made of the anticipated amount of traffic, classified as to types of vehicles, that might use the new project—operating as a toll-free facility.

BASIS FOR SETTING TOLL RATES

Supplementing this estimate, there should be prepared a new estimate of traffic volumes after applying toll rates for each class of vehicle to be charged for use of the new facility. Doubtless, a reduced number of vehicles using the facility would result, because of the resistance to payment of toll. These suggested toll rates must be equitable and fair for each class of vehicle and, after full consideration of all factors involved, should result in a maximum gross earning for the project. Naturally, there is a point of diminishing return when the toll rates established exceed benefits to users.

Where a bridge or tunnel replaces a ferry, it has been general experience that the new toll rates are in line with those charged on the ferry. Consideration of the final recommended toll rate should take into account a possible reduction in the ferry rate, in the event that the ferry is kept in operation after the new facility is completed. Likewise, the same consideration must be given to other competing facilities in the area and their possible rate reductions to meet new competition.

In this study of the derivation of toll rates for highway bridges and tunnels, information was collected on most of the highway bridges and tunnels, as well as the ferries, now in operation in many parts of the United States. As might be expected, there is a wide variation in charges for each type of vehicle crossing. The basic reason is that each of the facilities cost a different amount to construct, and served varying volumes of traffic. In the case of toll roads, most toll rates are based upon a basic rate per mile, again varying with the advantages offered and the cost of constructing the facility to serve the traffic.

USER-BENEFITS FROM TOLL FACILITIES

After traffic and other investigations have been completed, one of the very important problems is to develop a schedule of toll rates that will furnish revenues to defray the cost of the project and at the same time afford each vehicle-class a margin in value received in return for toll payment. To arrive at this value, it is necessary to make a study of benefits that would accrue to the user.

Benefit of time-saving to the passenger-car driver may be important, or of no consequence, depending upon the purpose of the trip, while the distance saved definitely would mean a cash saving. In the case of the commercial user, distance-saving is the most important factor and only in certain instances does time-saving become of interest. In determining the proper toll rates, time-and distance-saving studies, therefore, are important factors upon which a definite monetary value can be fixed. Other factors that must be considered, however, include safety, comfort, and convenience.

Listed herewith are examples of toll rates in force on various bridges and tunnels throughout the country. It is interesting to note the differences, particularly in truck rates, for bridge crossings of the same river.

BRIDGE CROSSING		*Automobile Toll Rate*	*Truck Toll Rate*
MISSISSIPPI RIVER			
Chain of Rocks	St. Louis, Mo.– Mitchell, Ill.	$.25	$.40
Chester	Chester, Ill.– Claryville, Mo.	.60	.75 to .90
McKinley	St. Louis, Mo.– Venice, Illinois	.25	.35 to .75
Rock Island Centennial	Rock Island, Ill.– Davenport, Iowa	.10	.15 to .25
Savannah Sabula	Savannah, Ill.– Sabula, Iowa	.35	.35 to 1.25
Veterans Memorial	St. Louis, Mo.– E. St. Louis, Ill.	.15	.30 to .75
Eads	St. Louis, Mo.– E. St. Louis, Ill.	.15	.30 to .85
Eagle Point	Dubuque, Iowa – Grant Co., Wisc.	.15	.25 to .75
Fort Madison	Fort Madison, Iowa – Niota, Ill.	.25	.25 to 1.60
Iowa-Illinois Memorial	Davenport, Iowa – Moline, Ill.	.15	.15 to .30
Gateway	Clinton, Iowa – E. Clinton, Ill.	.20	.20 to 1.50
Keokuk Municipal	Keokuk, Iowa – Hamilton, Ill.	.10	.25 to 1.50
Lyons and Fulton	Clinton, Iowa – Fulton, Ill.	.20	.20 to 1.50
Muscatine	Muscatine, Iowa	.35	.35 to 5.00
Vicksburg	Vicksburg, Miss.– Delta, La.	.50	1.50 to 3.00
Jefferson Barracks	St. Louis County, Mo.– Columbia, Ill.	.20	.40
Douglas MacArthur	St. Louis, Mo.– E. St. Louis, Ill.	.15	.30 to .60
MISSOURI RIVER			
Bellevue, GAR Memorial	Bellevue, Nebraska	.50	.85 to 1.00
Decatur	Decatur, Nebraska	.50	.50
Abraham Lincoln Memorial	Blair, Nebraska	.50	.50 to 1.50
Mormon Pioneer Memorial	Omaha, Nebraska	.35	.35 to 1.00
Platsmouth	Platsmouth, Nebraska	.50	.50 to .85
Rulo	Rulo, Nebraska	.75	.85 to 1.00
Miami	DeWitt, Mo.	.40	.40 to .75
Phelps City	Phelps City, Mo.– Brownville, Neb.	.60	.70 to .85
OHIO RIVER			
Kentucky-Indiana	Louisville, Ky.– New Albany, Ind.	.20	.15 to .25
Shawneetown	Shawneetown, Ill.	.75	.75 to 2.50
Suspension	Cincinnati, Ohio – Covington, Ky.	.10	.15 to 1.50
Fort Steuben	Steubenville, Ohio – Wierton, W. Va.	.10	.10 to .50
Lower Bridge	Newell, W. Va.– East Liverpool, Ohio	.10	.15 to .50
Memorial Bridge	Parkersburg, Va.– Belpre, Ohio	.15	.30
DELAWARE RIVER			
Delaware Memorial	Farnhurst, Del.– Deepwater, N.J.	.50	.75 to 3.50
Benjamin Franklin	Philadelphia, Pa.– Camden, N.J.	.25	.25 to 2.00
Walt Whitman	Philadelphia, Pa.– Gloucester, N.J.	.25	.25 to 2.00
Tacony-Palmyra	Philadelphia, Pa.– Palmyra, N.J.	.05	.05 to .50
Burlington-Bristol	Burlington, N.J.– Bristol, Pa.	.05	.05 to .50
Delaware Water Gap	Delaware Water Gap, Pa.– N.J.	.25	.25 to 1.00
Morrisville-Trenton	Morrisville, Pa.– Trenton, N.J.	.15	.15 to .40
HUDSON RIVER			
George Washington	New York City – Fort Lee, N.J.	.50	.50 to 1.50
Bear Mountain	Peekskill, N.Y.	.25	.25 to 1.00
Poughkeepsie	Poughkeepsie, N.Y.	.25	.25 to 1.00

With respect to the above tabulation, it should be pointed out that these projects were constructed at different times and, therefore, at considerable difference in cost level. This cost factor, however, is only one of several factors having a bearing on the toll rates established.

In many cases in the foregoing tabulation, toll rates that prevailed on the ferries in operation prior to construction of the bridges are lacking. However, toll rates charged by the ferries prior to bridge construction were adopted for the basic toll rate for use of the bridge.

CHESAPEAKE BAY TUNNEL-BRIDGE PROJECT

One very interesting project, now under consideration, is the crossing of Chesapeake Bay from Cape Charles area to the mainland, in the vicinity of Norfolk ,Virginia. The present ferry operating in this area requires about one and a half hours for the trip. A combination tunnel and bridge project is being considered to replace the ferry and, when completed, will afford a much superior route from the north to eastern Virginia, the Carolinas, and Florida areas. Toll schedules for the present ferry operation, and those recommended for the fixed crossing, are of particular interest and are quoted from the report of a consultant:

"The toll rate for passenger car and driver is presently $3.83, including the applicable federal tax. It is proposed that the toll rate be rounded to an even $4 for the proposed fixed crossing. For commercial vehicles, an axle, rather than length, classification has been used since it is more adaptable to simple toll-collection equipment and will facilitate good control records and audits. At the present time, vehicles in the pick-up and panel truck classification are assessed a total toll charge, including tax, of $5.23 for vehicle and driver. The proposed toll schedule assumes a $5 toll rate for this vehicle classification.

"Present toll rates for the larger commercial vehicles vary from $5.50 plus $.75 for driver, and applicable federal tax, to $30 plus a $.75 charge for driver and applicable tax. Under the proposed toll schedule, toll charges for commercial vehicles would vary from $7 to $16. The two-axle truck with six tires would pay a total fee of $7 for vehicle and driver; three-axle trucks, $10; four-axle vehicles, $13; and five-axle vehicles, $16.

"Separate vehicle toll classes are proposed for buses. A two-axle bus and driver would be charged $9; a three-axle bus and driver, $10. Extra passengers on all vehicles would be charged a flat fee of $.85.

"Including the toll classification for passengers, the recommended toll schedule consists of nine toll classes."

The present toll schedule for Chesapeake Bay ferries is shown in the following tabulation:

TOLL SCHEDULE*
CHESAPEAKE BAY FERRIES

Passenger, 6 years or older	$ 0.75
20-trip book, good until used	12.00
Automobile	3.00
Motorcycle	1.00
with side car	1.50
Bicycle	.50
All other vehicles or combinations pay by total length:	
Under 20 feet	$ 4.40
20 to 25 feet	5.50
25 to 30 feet	6.60
30 to 35 feet	7.70
35 to 40 feet	8.80
40 to 45 feet	9.90
45 to 50 feet	12.50
50 to 55 feet	13.75
55 to 60 feet	18.00
60 to 65 feet	19.50
65 to 70 feet	21.00
70 to 75 feet	22.50
75 to 80 feet	24.00
80 to 85 feet	25.50
85 to 90 feet	27.00
90 to 95 feet	28.50
95 to 100 feet	30.00

*Add 10 percent federal transportation tax to all cash passenger fares.

The recommended toll schedule for the Chesapeake Bay fixed crossing is shown in the following tabulation:

RECOMMENDED TOLL SCHEDULE
CHESAPEAKE BAY FIXED CROSSING
VEHICLE AND DRIVER

Vehicle Toll Class	*Toll Rate*
Passenger car and motorcycle	$ 4.00
Pickup and Panel Truck	5.00
Two-axle 6-tire truck	7.00
Two-axle bus	9.00
Three-axle single-unit truck, three-axle semi-trailer, or Passenger car with single-axle trailer	10.00
Three-axle bus	10.00
Four-axle semi-trailer, passenger car with two-axle trailer	13.00
Five-axle semi-trailer, other large and special vehicles	16.00
Passenger, each	.85

In the classifications set forth for the bridge and tunnel crossing, the length of the vehicle is of no consequence, whereas on the ferry, naturally, it is of paramount importance.

The development of toll schedules for bridges and tunnels has been aimed at simplification, to avoid questionable decisions by toll collectors as to size and weight of the vehicle for which a toll is to be charged. Most recent toll schedules have been developed on the basis of the number of axles rather than upon the weight of the vehicle. A simple description of the vehicle type, including the number of axles, is sufficient for a toll collector to classify the vehicle and request the proper toll for such a vehicle crossing.

Pilferage, with respect to toll-collection operations, is a serious matter. Great efforts have been made to set up toll-classification systems that are nearly fool-proof, leaving nothing to the discretion of the toll collector and making it mandatory upon him to classify the vehicle properly and collect the proper toll. Naturally, this matter is of extreme importance to the bond holder, or owner of the project.

Toll rates established for various classes of vehicles fully consider toll rates of any facility they are to replace. In those cases where no facility existed, judgment must be exercised to establish toll rates in line with benefits and savings to the potential user.

The realization of an adequate return is a matter that must be studied from time to time after the project is in operation. Adjustments must be made to provide sufficient revenues to meet the obligations of owner and operator.